AUGUST
1960

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ELECTRICAL CONSTRUCTION AND MAINTENANCE

WITH ELECTRICAL CONTRACTING

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Grounding and bonding service entrance equipment — a round-up of rules, methods and devices.

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A winning combination of rugged strength, beauty and efficiency in a concave plastic fixture! The Gateway introduces a new concept of design and construction. Plastic is basic . . . but no wrap-a-round. Concave bottoms hinge separately . . . choose GrateLite Louver Diffuser* or Prismoid GrateLite Louver-Lens**.

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with Concave PRISMOID

Rows of lamps	Room Index			
	D	C	B	A
2-lite	52 FC	59 FC	67 FC	71 FC
3-lite	78 FC	89 FC	101 FC	107 FC
4-lite	99 FC	113 FC	129 FC	136 FC

with Concave GRATELITES

Rows of lamps	Room Index			
	D	C	B	A
2-lite	48 FC	54 FC	62 FC	66 FC
3-lite	72 FC	81 FC	95 FC	99 FC
4-lite	91 FC	105 FC	118 FC	125 FC

Notes: Room index D is for 30′ x 36′ room using 3-28′ rows
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Room index B is for 50′ x 56′ room using 5-48′ rows
Room index A is for 60′ x 60′ room using 6-52′ rows

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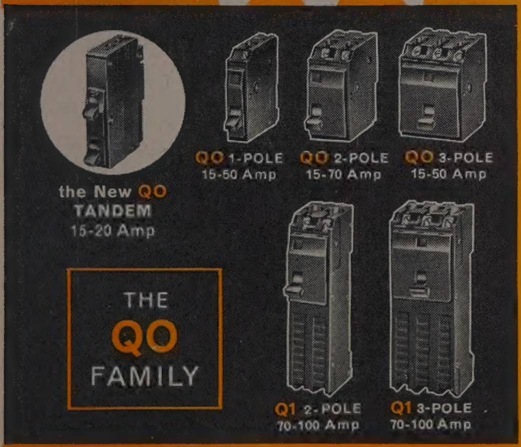

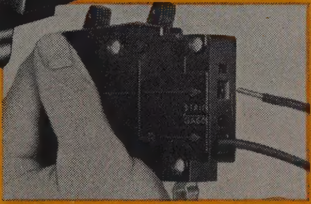

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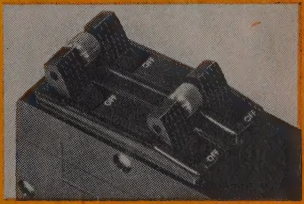

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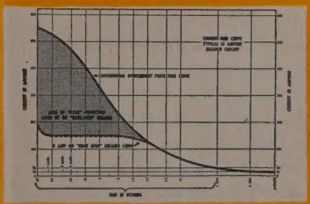

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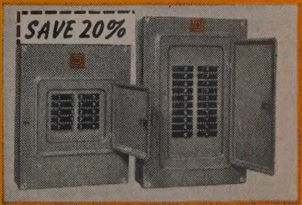

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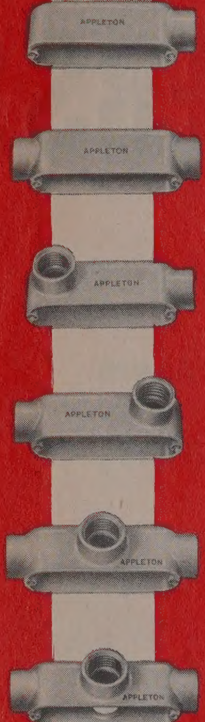

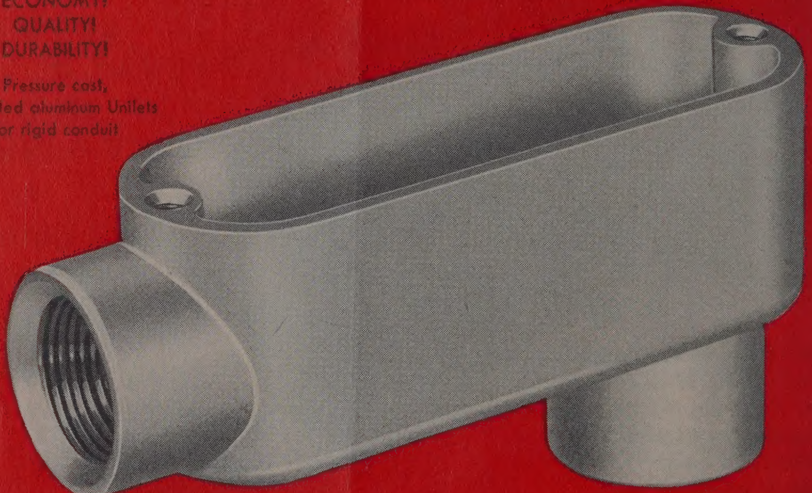

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Published for electrical contractors, electrical departments in industry, engineers, consultants, inspectors and motor shops. Covering engineering, installation, repair, maintenance and management in the field of electrical construction and maintenance.

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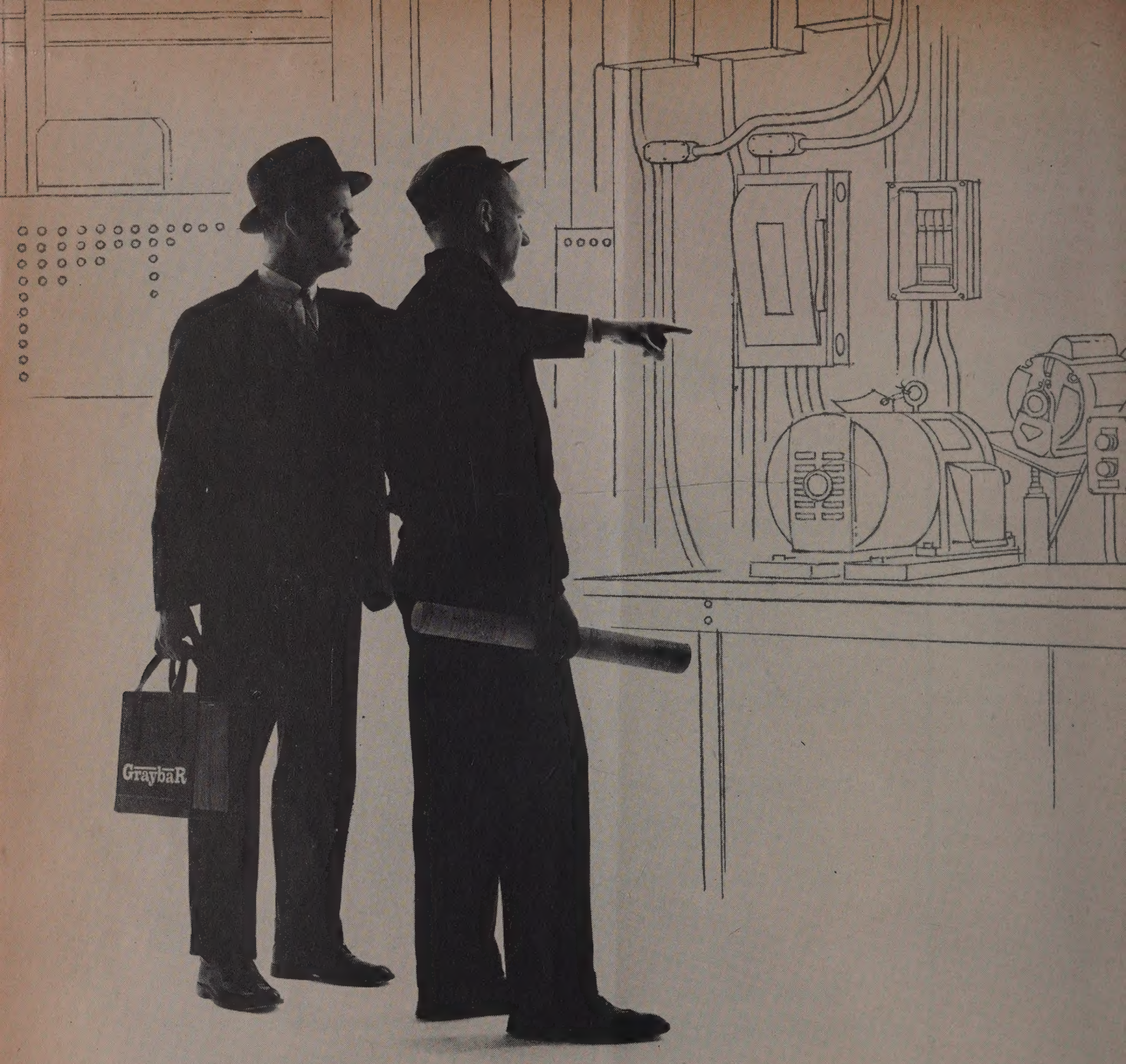

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ELECTRICAL CONSTRUCTION AND MAINTENANCE

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Kamklamp Fuse Holders in

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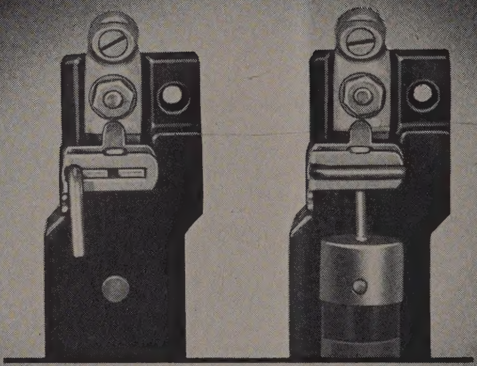
prevent loose connections that generate heat



Levers in Kamklamp Fuse Holders grip knife-blade terminals between vise-like case hardened steel jaws; ferrule terminals under tightly drawn steel bands. Eliminated are connections that loosen and burn.

TYPE SCSD
Standard Duty
30 to 200 amps;
240-v.—600-v. AC

TYPE SAHD
Heavy Duty
30 to 1200 amps.,
240-v.—600-v. AC

Kamklamp Fuse Holders—*exclusive* in Frank Adam Switches—lock cartridge fuse terminal immovably in position, and provide tight, flexible connections under constant tension that will not become loose and heat up. Overloads cause heat and expansion, then subsequent cooling and contraction, which loosens ordinary contacts making them flash and burn. Kamklamp Fuse Holders help eliminate this major cause of trouble.

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Sidelights

GROUNDING SERVICES

The National Electrical Code, local electrical ordinances and utility requirements set forth strict rules regarding the grounding and bonding of electrical service equipments. Effective methods are increasingly critical due to the larger capacities of service entrances. Associate Editor J. F. McPartland presents a comprehensive round-up of grounding and bonding practices from the pertinent rules, through methods and devices, to the basic engineering requirements in an article, "Grounding and Bonding of Services" beginning on page 67.

HIGH FREQUENCY HEATING

Among the processes for producing sophisticated metals and super-alloys is the vacuum induction furnace. High frequency currents induced in the melt through the walls of the sealed crucible does the job. Behind the process is, of course, a complex electrical system. Robert J. Lawrie describes the recent installation of vacuum induction furnaces in the Kelsey-Hayes, Metals Division plant in New Hartford, N. Y., in the article "Vacuum Induction Heating" beginning on page 80. Mr. Lawrie was project engineer for the new plant during construction.

HANGAR LIGHTING

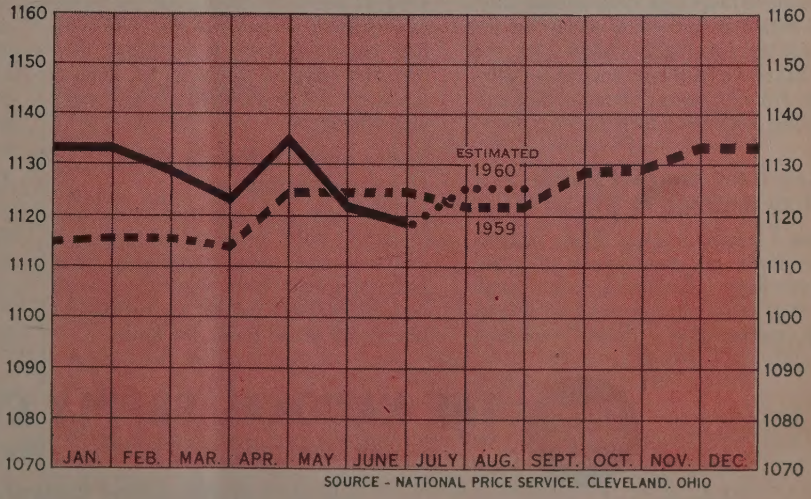
High bay lighting equipment, using color corrected mercury lamps, lights the new American Airlines' hangar at New York International Airport to a level of 65 footcandles average eliminating the need for portable stanchion lights even for close-up mechanical work. The lighting is of such uniformity that there are no shadows beneath berthed planes. The huge building can shelter ten giant jet transports at one time. Associate Editor B. C. Cooper describes the lighting design, layout and installation in "High Level Hangar Lighting" on page 78.

ALL-ELECTRIC MOTEL

Full electrical facilities including heating and cooling are incorporated in the luxurious apartments at Fisherman's Wharf Motel in St. Clair, Mich. The electrical systems are under finger-tip control from a centralized master indicator panel. W. T. Gove, of Minneapolis-Honeywell describes the advanced electrical system installation in "Luxury Motel Goes All-Electric" beginning on page 88.

ELECTRICAL MATERIALS COST INDEX

BASE LINE (1000) REPRESENTS COSTS OF TYPICAL ASSORTMENT OF MATERIALS FOR A SELECTED JOB AS OF NOVEMBER 1, 1951. INDEX POINTS REPRESENT THE VARIATION OF THESE SAME MATERIAL COSTS AS OF THE FIRST OF EACH MONTH.



SOURCE - NATIONAL PRICE SERVICE, CLEVELAND, OHIO

New Duracron Enamel Finish provides safety on the job plus lifetime protection for this Spang Standard Underfloor Duct installation.

Now—SPANG® Underfloor Duct Systems with new Duracron enamel finish provide extra protection against corrosion

That well-known yellow finish on Spang Underfloor Duct now does double duty. In addition to providing safety on the job site through highly visible color, the new baked-on Duracron enamel provides better anti-corrosion protection than galvanizing, according to laboratory tests!

Extra-hard enamel finish resists damage at job sites

Spang Underfloor Duct often receives heavy traffic and wear at job sites, but this new finish is designed to take a tough beating. It's a thermo-setting acrylic resin, representing a radical departure from current baking enamels. It is extremely hard, insoluble and infusible after baking. It has superior adhesion, high color retention; is marproof, flexible, and resistant to chemicals, impact, humidity, salt spray, water, grease, stains and detergents.

Tests show finish is better than galvanizing

A 2,064-hour salt spray test on the new Duracron finish produced no apparent attack of the coating or corrosion of the underlying steel. Even where the coating was deliberately scored, corrosion did not spread or get under the finish.

The same test on galvanized steel produced thin to moderate rust and some pitting of the underlying steel over about 60% of the surface, proving that the new Duracron finish offers you better corrosion resistance. This new finish will also withstand all normal chemical action encountered in concrete.

Duracron assures top anti-corrosion protection

With this protection, you are assured that Spang Underfloor Duct will provide extra safety to your wiring installations. You just can't get a finer finish! Look for it on your next Spang job.

SPANG® UNDERFLOOR DUCT

THE NATIONAL SUPPLY COMPANY
Two Gateway Center, Pittsburgh 22, Pennsylvania
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Washington Report

AUGUST • 1960

The business outlook continues cautiously optimistic, as the second half of 1960 gets under way. Midyear government statistics on the national economy show it rolling along up a very slight incline, under its own steam with sustained pulses of power from growing personal income, record high employment, and increased spending for personal consumption. The nation's total output of goods and services (gross national product) in the second quarter hit a seasonally-adjusted annual rate of $505 billion. This was a record, but was up only $3.7 billion, or less than 1%, from the first quarter rate. National output (GNP) last year was $482 billion, for the year, and a January forecast of $510 billion for 1960 was made by the Administration. This target now seems unlikely.

Federal income exceeded Federal spending in fiscal year 1960 by $1,068 million, President Eisenhower disclosed in July. Budget receipts totaled $78,368 million, compared with $68,270 million for fiscal 1959, while expenditures for fiscal 1960 were $77,299 million, and for fiscal 1959 were $80,697 million. Thus the 1959 deficit was $12,427 million.

New construction spending dropped 3% over the first half of 1960 from the similar period last year, Depts. of Commerce and Labor reported. The actual expenditures were $24.5 billion.

Value of new construction put in place in June totaled $4.9 billion, up 7% from May. Of this total, public construction amounted to $1.5 billion, up 9% from May, while private construction spending totaled $3.4 billion, nearly 7% over May.

Spending for private residences over the first six months totaled $9.6 billion, down 7% from the similar 1959 period. Housing starts on private new homes in June totaled 125,200, or 2,300 below the 127,500 starts reported for May. The June rate was 15% below that of May 1959.

Highway construction during first five months of this year trailed 13% behind last year's rate for the same period. The Commerce Department has authorized the states to double the amount of Federally assisted road construction contracts issued in the July-September fiscal quarter, from an original $718.4 million authorization to some $1.4 billion.

Shipments of integral hp motors and generators this year will likely exceed 1959 shipments by about 8%, according to midyear forecast of the Electrical Equipment Division, BDSA, Dept. of Commerce.

Some economic highlights:

- **Employment** in June broke all records. Jobholders totaled 68,579,000, or a gain of 1.4 million over May and a million higher than the record of July 1959.
- **Retail sales** in 1960 have broken all records. For the second quarter, sales were $56.1 billion, up 3.2% over similar quarter of last year, and for first six months of this year, sales totaled $110.6 billion or $3.3 billion higher than same 1959 period.
- **Personal income** hit an annual pace of $405.8 billion in June, a record, despite declines in the steel and aircraft industries.
- **Industrial production** in June was at a seasonally adjusted FRB Index of 109 (1957 equals 100), and held within a 2-point range (109-111) during the entire first half of the year.
- **Steel production** has dropped to near 50% of capacity at midyear, has now inched up slowly to about 56%, but Commerce Dept. has predicted steel mills will turn out 110 to 112 million tons during the year, for an average of about 74% capacity.

Almost 50% saving "just around the bend"

NEW Blackhawk 4" one-shot bender

Talk about spectacular savings — *you pocket more than $11 per bend over other methods.* This new Blackhawk bender pays for itself on just a couple of jobs. From then on it's gravy all the way.

This portable bender goes right to the job. You eliminate about half of the fittings, pipe threading and the time it takes to make connections.

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CATALOG / MANUAL L-400 has full details on Blackhawk's family of time-saving, money-saving pipe benders.
Write Dept. P-2080 today for your free copy.

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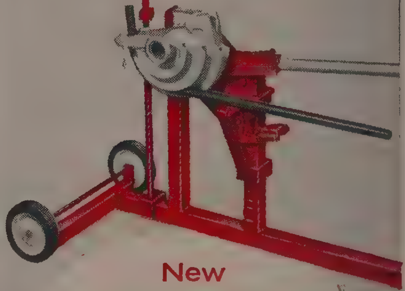
Take the guesswork out of hand bending

Here's Blackhawk's new rigid and thinwall hand bender that makes perfect 45° and 90° bends. As accurate as a carpenter's level, Blackhawk's Level Bender has unique double "bubbles" to do the figuring for you. You'll be amazed at the ease with which you make 90° bends, offset bends, saddle bends, back-to-back bends in ½", ¾" or 1" thinwall. Aluminum alloy construction is lightweight, yet built for hard work.

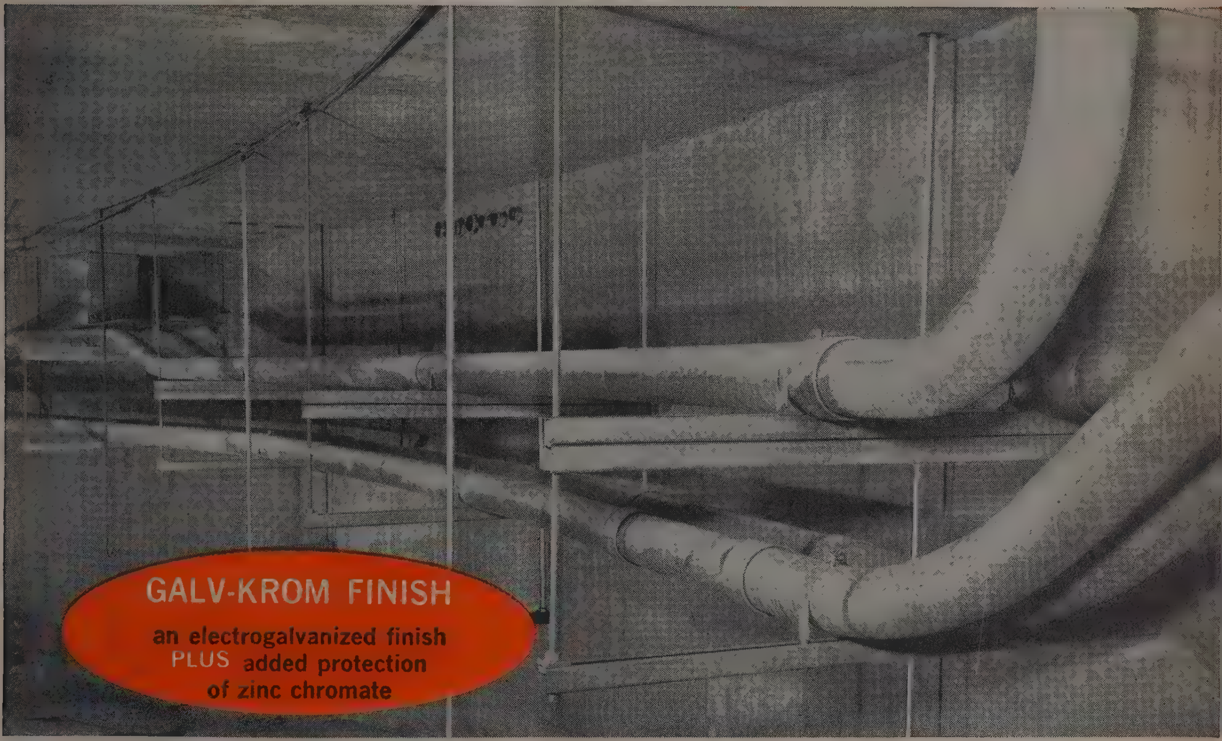


New Ratchet Rig saves on "ells"

Foolproof ratchet action makes perfect "ells," eliminating the extra expense of manufactured ells. The rig is easy to operate —anyone can do it after a few minutes' instruction. Lock-on shoes are quickly interchangeable to bend rigid conduit or aluminum. An "Optik-Angle" gage assures bending accuracy. Ratchet Rig is either portable or can be mounted on a pickup truck.

STEEL CITY Hanger Rod

—an integral part of the electrical system



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an electrogalvanized finish PLUS added protection of zinc chromate

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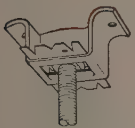
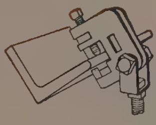
A wide variety of fittings for every type of installation

H-195
Steel Rod Coupling

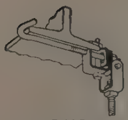


D-255
Concrete Insert

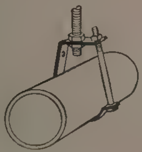


E-232
Clamp with
Swing Connector

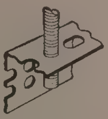
H-260
Swivel Joint



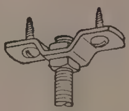
E-165
Adjustable Beam Clamp
with Swing Connector



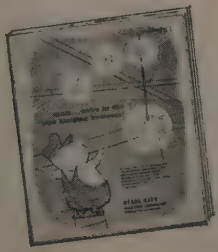
C-149
Adjustable Conduit
and Pipe Hanger



With Steel City
Slotted Angle



E-243
Ceiling Flange



'got a
hanging problem?

WRITE FOR
BULLETIN PH-1

See Your STEEL CITY
Distributor For The
Hanger Rod And Fittings
That Meet Your
Electrical Requirements

Threads are:

- **FREE RUNNING**—*Clean, Uniform*
- **RUST PROOF**—*No Paint Required*
- **BURR FREE**—*Smooth Finish*

ALL-PURPOSE HANGER RODS

72″ Lengths
Continuous Threads
¼″, ⅜″, ½″ and ⅝″ Diameters

LONG-THREADED RODS

Lengths 2″ through 18″—
Continuous Threads
Lengths 24″ through 72″—
Threaded 4″ one end and 10″ other end
⅜″ and ½″ Diameters

STEEL CITY ELECTRIC COMPANY
Subsidiary of American Marietta Company
PITTSBURGH 33, PA.

1′ x 4′ PLEXIGLAS lenses mounted in continuous line, Ronkonkoma Primary School, Long Island. Architect for both schools shown: Frederick E. Allardt, Jr.

2′ x 2′ PLEXIGLAS lenses mounted in pairs, Southampton High School, Long Island.

PLEXIGLAS

for lighting that stands out and stands up

When lighting equipment includes control lenses molded of PLEXIGLAS® acrylic plastic, the result is illumination of the highest quality—because PLEXIGLAS is:

- molded accurately to the lens pattern, to produce a precisely designed optical element which achieves functional quality illumination. With lenses of the types shown in the installations above, light rays are "bent", providing complete freedom from glare at any normal viewing angle.
- impervious to discoloration from years of exposure to fluorescent light.
- strong and rigid yet light in weight, resulting in safety overhead and ease of maintenance.
- crystal clear, assuring full utilization of light with complete visual comfort.

Full details on PLEXIGLAS as a lighting material are contained in our new technical bulletin, "PLEXIGLAS for Lighting". We will be glad to send you a copy.

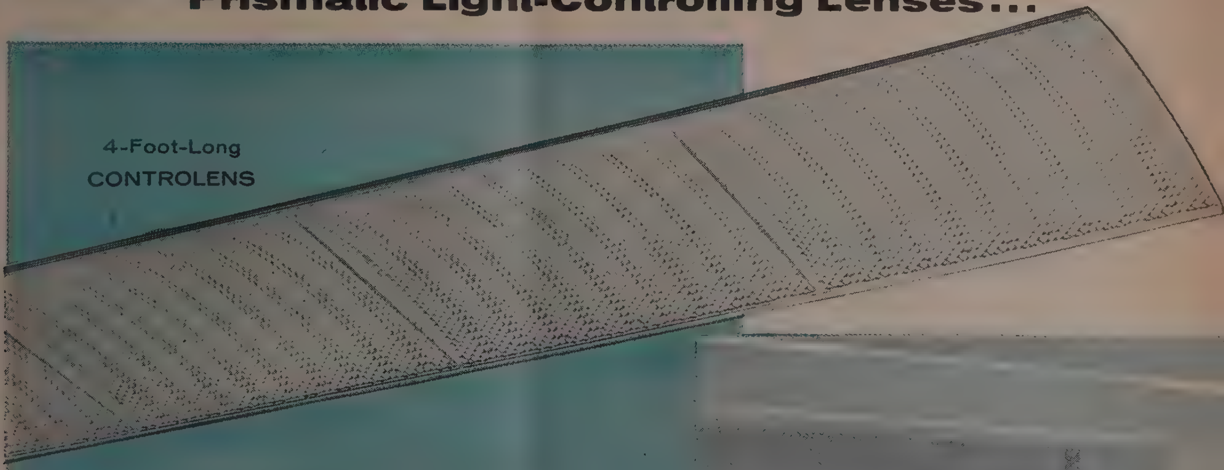
Chemicals for Industry

ROHM & HAAS COMPANY

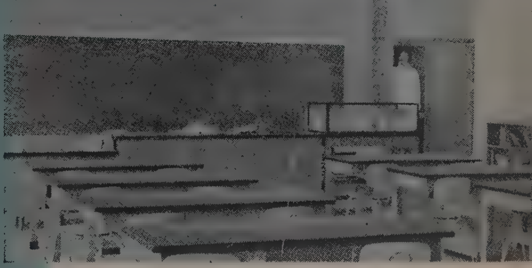
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario*

ACRYLIC PLASTIC...The Proven Material for Modern, Prismatic Light-Controlling Lenses...



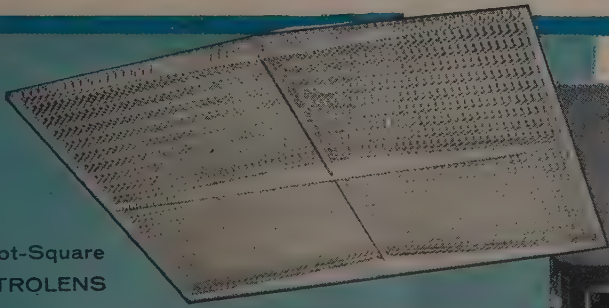
4-Foot-Long
CONTROLENS



Wherever the PRISMALUME CONTROLENS has been used it has delivered consistently superior performance: high level illumination with the utmost visual comfort. Its prismatic construction provides effective light control with the best "hiding-power" to conceal light sources. The use of crystal-clear acrylic plastic produces a CONTROLENS that is light in weight, shatter-resistant, free from discoloration and altogether different in its distinctive, quality appearance. Reinforcing struts assure great dimensional stability... Available in a variety of shapes for a wide range of fluorescent applications.

4-Foot-Long CONTROLENS, singly or in continuous runs, are advantageously used in classrooms, offices, banks, showrooms, libraries, stores, lobbies and laboratories.

HOLOPHANE PRISMALUME® CONTROLENS®



2-Foot-Square
CONTROLENS

The flexibility of the 2-Foot-Square CONTROLENS makes it adaptable in many ways, such as: • Geometric groupings (one or more lenses)... • 2-ft-wide continuous troffer runs... • Large luminous panels.

Write for Engineering Data

HOLOPHANE COMPANY, INC.
Lighting Authorities Since 1898
342 Madison Ave., New York 17, N. Y.
THE HOLOPHANE CO., LTD., 418 KIPLING AVE. SO., TORONTO 18, ONT.

ALLIS-CHALMERS

Now — faster, easier hookup with new, 3-piece case design.

All-new dry-type transformers

...on the wall, wired, closed in half the time!

Now 35% smaller, lighter—new Allis-Chalmers ventilated, dry-type transformers feature exclusive 3-piece case that cuts installing time from 90 to *just 40 minutes!* New, compact size opens additional installation site possibilities previously considered too tight for conventional units.

Noise level is reduced to no-hum, whisper-quiet operation by employing core impregnation . . . by isolating core-and-coil assembly from the case . . . and by use of nonresonate casing. Low core losses and low exciting current result from superior *Curvacore* construction.

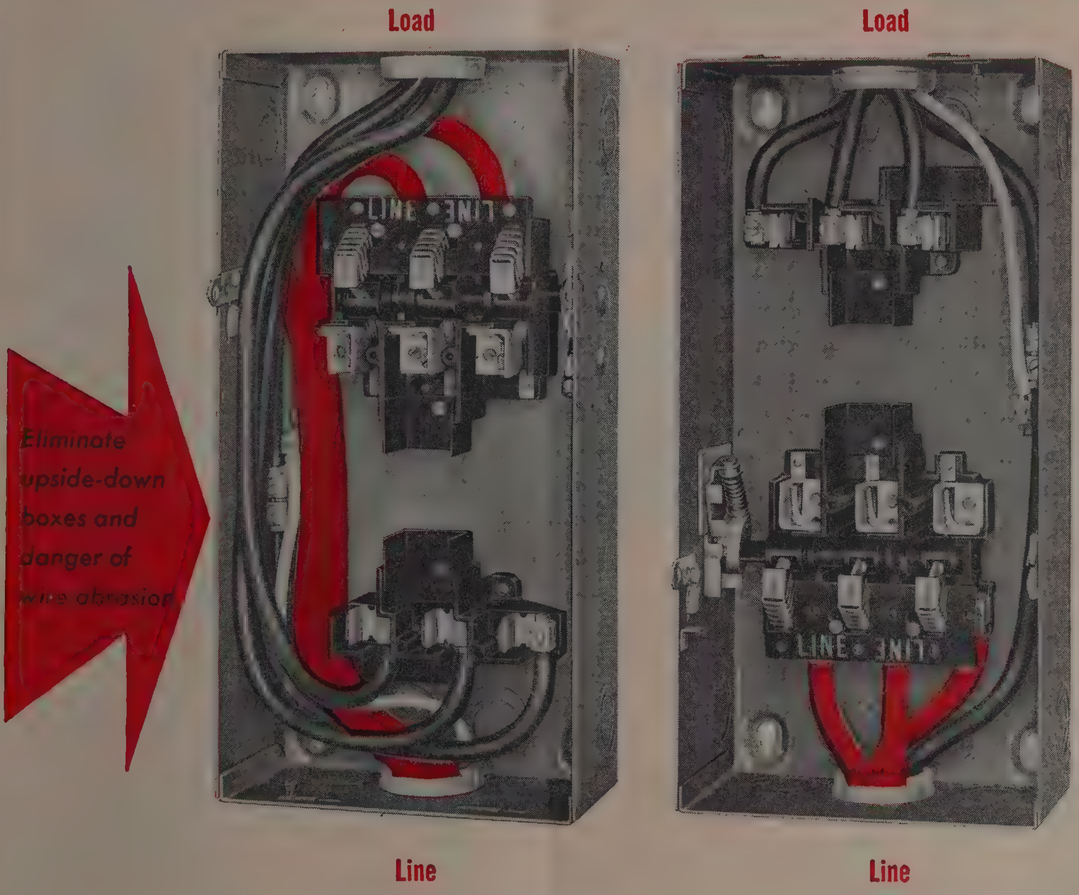
This new 600-volt class indoor transformer line is available in 3- to 50-kva sizes for on-the-site load center applications where critical voltage must be maintained. And the price is right!

Further details are available in Bulletin 61B8222A at your nearby A-C office, or write **Allis-Chalmers,** Power Equipment Division, Milwaukee 1, Wisconsin.

Curvacore is an Allis-Chalmers trademark.

A-1359

Save up to $30 on cable cost with new G-E reversible-wiring safety switches



Old way wastes wire, work and money. Looped cable inside box presents danger of wire abrasion. None of this is necessary when you use new General Electric reversible-wiring safety switches, 100-amp and above.

New G-E way eliminates danger of wire abrasion, inconvenience of upside-down boxes. ON-OFF indication remains unchanged. Available with line lugs factory-installed at bottom, or for field installation.

SCHEDULE [illegible] ON CONDUCTOR [illegible]

Switch Rating	Conductor Size	Amount Saved Per Switch Installed*		Length of Wire Saved (In Feet)	
		2-Pole	3-Pole	2-Pole	3-Pole
100 AMP	2	$ .91	$ 1.36	5	8
200 AMP	3/0	3.73	5.60	9	14
400 AMP/240 VOLT	500 MCM	12.56	18.90	11	16
400 AMP/600 VOLT	500 MCM	13.74	20.60	12	17½
600 AMP/240 VOLT	(2) 350 MCM	18.70	28.10	22	33½
600 AMP/600 VOLT	(2) 350 MCM	20.40	30.60	24	36½

*Based on approximate contractor prices for Type RHW copper building wire.

GENERAL ELECTRIC

Circuit Protective Devices Dept., Plainville, Conn.

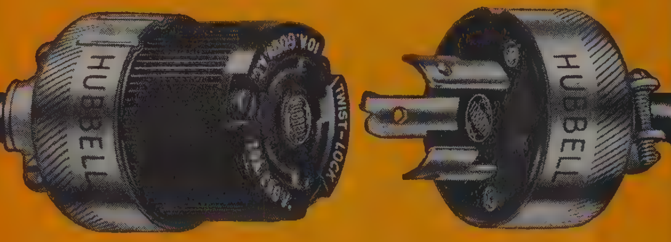
ONLY

HUBBELL

MAKES ***SUPER***

Twist-Lock®

WIRING DEVICES



CAT. NO. 3323
SUPER TWIST-LOCK
ARMORED BODY
20 AMPERES, 250 VOLTS, AC OR DC
10 AMPERES, 600 VOLTS, AC ONLY

CAT. NO. 3321
SUPER TWIST-LOCK
ARMORED CAP
20 AMPERES, 250 VOLTS, AC OR DC
10 AMPERES, 600 VOLTS, AC ONLY

Super Twist-Lock devices are smaller, more compact and lighter in weight than regular Twist-Lock units. On the surface they look very much like their conventional brothers but actually they incorporate important construction features that place them in a class by themselves. Both the cap and connector body feature screwless pressure grip terminals which simplify and speed wiring and a revolutionary 2-piece dead front construction that seals out dust, dirt, lint, metal chips, etc. Terminals are pressure locked between the two independent sections so that all wiring is completely enclosed . . . the ultimate in wiring safety and security.

All units in the Super Twist-Lock line can be interchanged with regular Twist-Lock connectors of equal rating. This is most advantageous in industrial plants where regular Twist-Lock devices are now installed on machine tools or other equipment.

For complete information on Hubbell Twist-Lock devices, see Hubbell Catalog #29 or check Sweet's File 3lb/Hu.

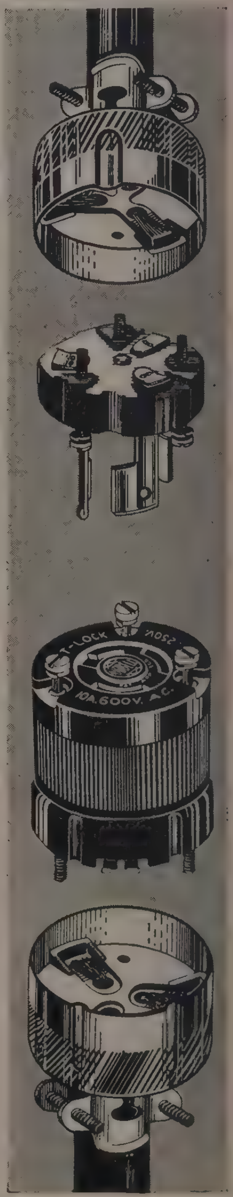
IT PAYS TO HAVE HUBBELL GOOD CONNECTIONS

HARVEY
HUBBELL
INCORPORATED
BRIDGEPORT 2, CONNECTICUT
In Canada: Scarborough, Ontario

engineering news

HARVEY HUBBELL, INCORPORATED
Engineering Department

Super Twist-Lock incorporates many advantages that contribute to substantial savings in installation time and effort. Tests also prove that it is the safest, most rugged unit of its type ever produced.



Improved Cord Grips
PROVIDE PULL-PROOF, PRESSURE-GRIP ON CABLE.

Convenient Knurled Strip Gage
SPEEDS WIRING.

Cap Shell Keyed
DIFFERENTLY FROM CONNECTOR BODY SHELL TO POSITIVELY PREVENT INTERCHANGE.

2-Piece Cap
ENGINEERED TO MAINTAIN POLARITY.

Broad Pressure Plate Contacts

Completely Dead Front
WITH NO EXPOSED WIRE ENDS TO COVER WITH FIBRE DISC. (DUST PROOF—DIRT PROOF, ETC.)

Greater Blade Rigidity . . .
ALWAYS IN ALIGNMENT, THUS MAINTAINING BETTER ELECTRICAL CONTACT.

Positive Polarity

Captive Holding Screws . . .
CAN'T FALL OUT . . . LOCKWASHERS PREVENT LOOSENING.

Heavy-Duty Bakelite
RESISTS VIBRATION AND ROUGH USAGE.

Key Slots
IN BAKELITE ASSURES PERFECT ALIGNMENT OF SPRINGS WITH SLOTS IN FACE. BLADES IN CAP FIT PERFECTLY AT ALL TIMES.

Screwless Pressure Terminals
SIMPLIFY WIRING AND PERMIT GREATER WIRING UNIFORMITY.

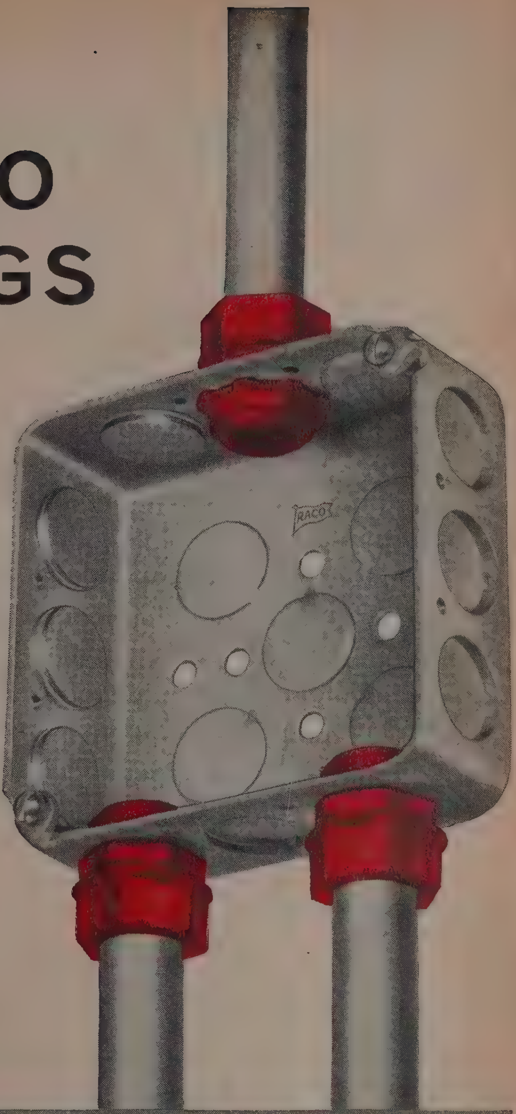
Connector Body Shell
KEYED TO PREVENT INTERCHANGE WITH CAP.

Rugged Steel Shell . . .
PROTECTS INNER CONSTRUCTION.

Twist-Lock is a registered trademark of Harvey Hubbell, Incorporated.

NEW RACO LINE OF FITTINGS

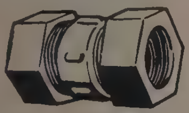
Charlie Raco
has a
new hat!



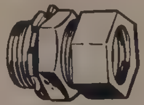
RACO, the complete box line, now offers you a complete line of fittings, too. There's a full line of RACO fittings for rigid conduit, E.M.T. (thinwall), armored cable, flexible metallic tubing, non-metallic cable, and service entrance cable.

And . . . the new RACO fittings are available in malleable iron, aluminum, steel, and pressure cast.

With this new addition to the RACO line, you now have a top-quality source for *all* your roughing-in materials. Your RACO Distributor has the new complete line of RACO products. Ask him about their time and money-saving features.

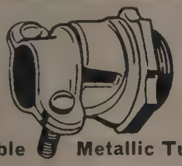


Rigid Conduit



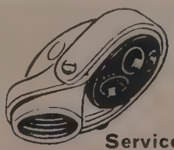
EMT (thinwall)

Armored Cable



Flexible Metallic Tubing

Non-metallic Cable



Service Entrance

NOW RACO HAS A COMPLETE LINE OF ROUGHING-IN MATERIALS

RACO **ALL-STEEL EQUIPMENT INC.** Aurora, Illinois

6 bonuses when you specify and/or install PTC TRANSFORMERS

bonus NO. 1 . . . EXTREME QUIETNESS

Quiet transformer operation with low loss is a blessing and a real source of satisfaction to building owners, managers, top executives, employees and patrons. Therefore a superior low noise level is an extremely important reason why you should specify and/or install PTC transformers on all jobs.

Look at these PTC low noise levels as they compare with present and recommended NEMA specifications.

KVA Transformer Rating	Present NEMA	Precision Average Sound Level Standard Design	Special Design
9—30	50	40	34
37½—112½	55	42	38
125—167	60	44	42
200—300	62	48	46

To recognize the extreme quietness of PTC transformers it is best to compare them in decibel sound level ratings with those of typical sounds familiar to everyday life.

FOR EXAMPLE:

60-70 decibels—the sound of one typewriter or average traffic sounds 100 ft. away.

50-60 decibels—the sound of a vacuum cleaner or moderate restaurant clatter.

40-50 decibels—the noise to be found in an average residence or in normal conversation.

30-40 decibels—low conversation in a residence in the evening.

bonus NO. 2 . . . EFFICIENCY

Transformer losses cost money. Precision transformer cores ① use the lowest loss steel available. Precision transformers are wound with low resistance copper wire and designed for the greatest possible operation economy. These features reduce losses and save dollars not once, but year after year.

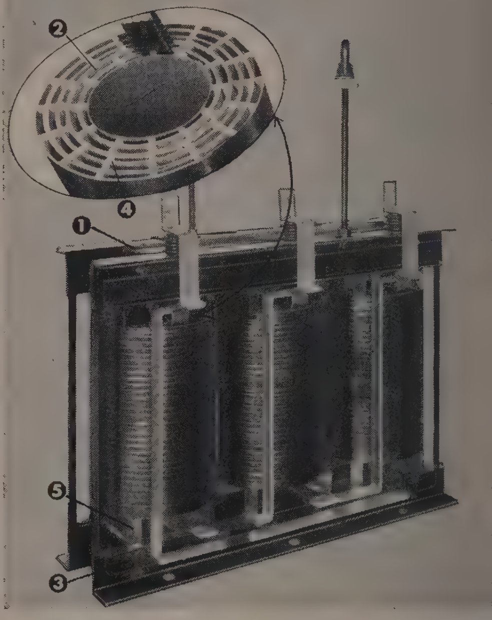
bonus NO. 3 . . . OVERLOAD CAPACITY

Precision transformers are designed with large open ducts ② for efficient cooling and operate at lower temperatures than specified in national standards. Superior PTC insulation materials, varnishes and wire enamels actually permit operating temperatures in excess of these standards with no loss of life. These factors together with low losses give Precision transformers unequalled ability to handle overloads.

bonus NO. 4 . . . DEPENDABILITY AND LONG LIFE

Dependability and long life can result only from ADVANCED DESIGN and BUILT-IN QUALITY. PTC transformers excel because they are constructed to meet the varying conditions under which they must be used. Additional PTC features are:

- Core laminations are clamped together with structural steel ③ rather than formed sheet steel for more rugged construction.
- Glass laminate duct spacers ④ used provide greater toughness, rigidity, dimensional stability, and moisture resistance far in excess of wood or paper phenolic laminate spacers.
- Coils are thoroughly clamped and braced around the core with fibre-glass laminate insulating blocks ⑤ resulting in greatest structural and tensile strength.
- Coils are made with an interlayer and interwinding insulation of Mylar-Quinterra and glass, assuring high dielectric strength, low moisture absorbtion and high temperature stability characteristics.



bonus NO. 5...REDUCED INSTALLATION EXPENS

Well designed and easily accessible mounting provisions together with ample connecting space and simpl wiring termination mean neater installations at lowe than normal cost.

bonus NO. 6 . . . THE ONLY 5-YEAR UNCONDITIONAL GUARANTEE IN THE INDUSTR

Your reputation as an electrical engineer or contractor depends upon YOUR ability to stand firmly behin your recommendations and installations.

It is reassuring to know that PTC transformers wor because PTC people make them work — then stand unconditionally behind them.

WHISPER-QUIET INSIDE-THE-WALL INSTALLATION

Precision Transformer Corporation has developed unit which installs *inside-the-wall* in otherwise unusabl space. Precision's "HUSH-FLUSH" design permits easy full accessibility, lowest noise level close to load powe service. Saves material and labor costs. Ideal for schools libraries, hospitals, churches, theatres, etc. — whereve noise *must* be eliminated.

Complete Line—DRY and LIQUID Types

Whatever your transformer needs, there is a dependable, quiet, long-lasting dry or liquid type transforme . . . more than 4,000 models ranging from ¼ to 5,000 KVA

Write today for 4-page brochure providing details o the PTC line.

PTC
TRANSFORMERS
• QUIET
• EFFICIENT
• DEPENDABLE

PRECISION TRANSFORMER CORP.
2222 West Lake Street • Chicago 12, Illinois
Representatives in all principal cities

Another **Rodale** Exclusive . . . Two Circuit *Touchette*®

DIM...MEDIUM...BRIGHT ILLUMINATION

...at the Touch of a Button

U.S. Pat. Nos. 2,820,113 2,928,920 2,933,579 Can. Pat. No. 588,449 Other Patents Pend.

WILL CONTROL THREE-LITE LAMPS FROM CONVENIENT WALL SWITCH

New Touchette ends the groping or stretching now in evidence with 3-lite fixtures. Touchette affords the welcome convenience of switching from an easy-to-see, easy-to-use standard location wall box. And, unlike rheostat-type switches, only the useable wattage is consumed. Perfect for dining room fixtures, ceiling fixtures and window displays.

Cat. No.
462

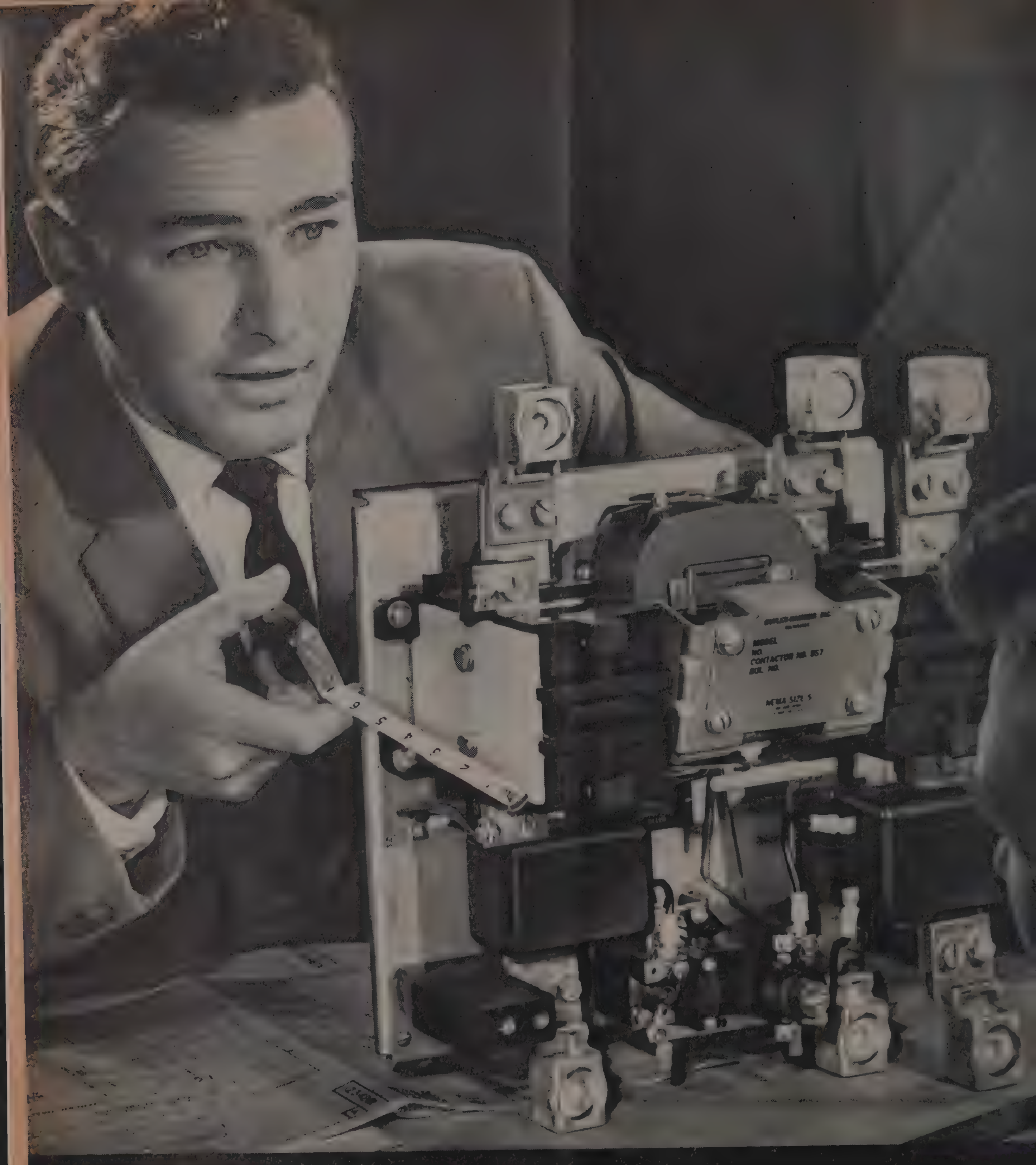
List Price
$1.60

WILL CONTROL 2 SEPARATE BANKS OF LIGHTS ON TWO SEPARATE CIRCUITS

Excellent for illuminated ceilings as well as many other commercial and industrial installations, Touchette two circuit wall switching will control alternate banks of lights . . . Switch will carry 1800 Watts at 120 Volts and 4100 Watts at 277 Volts. Convenience and economy are afforded . . . in addition to requiring just half as many switches, at least 25% of initial wiring is saved.

Sold only through electrical wholesalers.
Or for further information and prices,
write Rodale direct.

Rodale / manufacturing co., inc.
dept. ECM8 emmaus, pa.



THE NEW CUTLER-HAMMER SIZE 5 STARTER IS FAR MORE COMPACT THAN OTHE

NEW CUTLER-HAMMER SIZE 5	A	B	C	D
PANEL AREA 197 SQ. IN.	PANEL AREA 270 SQ. IN. 37% LARGER	PANEL AREA 322 SQ. IN. 63% LARGER	PANEL AREA 475 SQ. IN. 141% LARGER	PANEL AREA 645 SQ. IN. 227% LARGER
VOLUME 1480 CU. IN	VOLUME 2540 CU. IN. 71% LARGER	VOLUME 2820 CU. IN. 90% LARGER	VOLUME 5750 CU. IN. 224% LARGER	VOLUME 5775 CU 288% LARGE

CONTROL

Now! A complete line of easy-to-install Cutler-Hammer Starters including a new compact Size 5

7 sizes for use as components or as complete starters

(Size OO, O, 1, 2, 3, 4 and 5)

Now get all the advantages of Cutler-Hammer's Three Star starter line in seven sizes. You can control motors from fractional hp up to 200 hp, now that the new Size 5 is available.

The new Size 5 starter needs only an eight-inch deep case. Its open dimensions are only 13″ wide, 15 3/16″ high, 7½″ deep . . . and is available as a non-reversing or reversing starter or as a contactor.

Even the wiring's easier. Instead of struggling to force the line and load cables into the lug connectors, the lugs unbolt, and are easily reassembled.

You still get, of course, the famous Three Star advantages that have made Cutler-Hammer Starters so famous: dependable pivoted armature, vertical contacts that don't collect dust, ease of installation, ease of inspection and maintenance, plus many other features.

Be sure to send for Pub. LO-69-Q241 to get all the facts on the complete Cutler-Hammer Starter line.

What's New at Cutler-Hammer? There's a new spirit here. You can see it in the new products, the new engineering talent, the increased plant capacities. We're ready for the great growth of the sixties so you can be ready to meet the great demands upon your capacities. We'd like to tell you more. Contact the Cutler-Hammer electrical distributor or the Cutler-Hammer sales office nearest you.

WHAT'S NEW? ASK...

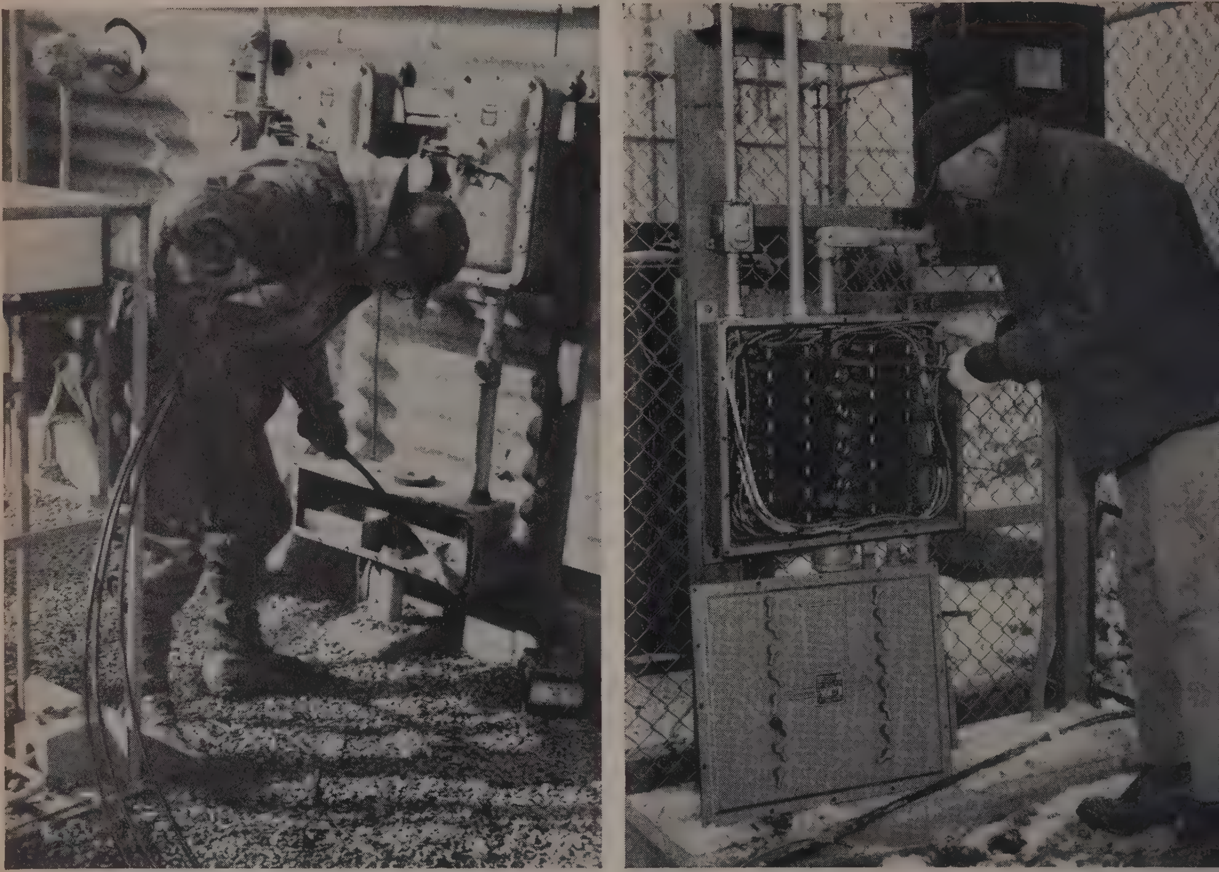
CUTLER-HAMMER

CONTROL

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.

Another new development using

B.F.Goodrich Chemical ***raw materials***



New THW wire insulated with Geon is used in sizes up to 3/0 AWG at this new Sohio plant. Wire is made by the Paranite Wire and Cable Division of the Essex Wire Corporation, Marion, Indiana. B.F.Goodrich Chemical Company supplies the Geon vinyl.

"We welcome the higher factor of safety"

. . . of new THW wire insulated with GEON vinyl

These pictures show new wiring going into the Sohio Chemical plant at Lima, Ohio. Here's what the contractor, W. W. Clark Corporation of Cleveland has to say about it:

"In a chemical plant or refinery, electrical wiring often has to go near processing equipment that operates at high temperatures. We try to keep it at least a foot away, but sometimes have to go as close as 6″. We welcome the higher factor of safety this new THW wire gives us."

Now you can add new heat resistance to the proved properties of insulation of Geon vinyl. Geon is tough, weatherproof and keeps its exceptional properties with age. It also resists oils, greases and chemicals.

For information about Geon wire and cable covering, or other ways that Geon improves products or opens new markets, write Dept. GY-5, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

A TRADE MARK OF B.F.GOODRICH CHEMICAL COMPANY
Geon
VINYLS
A DIVISION OF THE B.F.GOODRICH COMPANY

B.F. Goodrich Chemical Company
a division of The B.F.Goodrich Compan

B.F.Goodrich

GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizer

WORLD'S MOST WIDELY USED ELECTRICAL TEST INSTRUMENTS

AMPROBE®

THE ONLY LINE THAT COVERS ALL YOUR TESTING NEEDS

The original pocket size snap-around volt-ammeter-ohmmeter

AMPROBE RS-3

5 current ranges. 3 voltage ranges. Ohmmeter specially designed for the maintenance field. Rotary scale for faster reading and greater accuracy. Pointer-Lock "freezes" pointer at reading. Advanced printed circuitry laughs at rough handling. Advanced movement design—new internal core magnet with self shielding characteristics. **By itself, the Amprobe RS-3 handles 99% of your test needs. With the Amprobe Deca-Tran and Amprobe Energizer it covers EVERY testing situation.** *Only* **$52.50**

AMPROBE RS-1

The economy snap-around volt ammeter with many features of the great RS-3 including rotary scale, pointer lock, printed circuit, and advanced movement design. 4 current ranges. 2 voltage ranges.

Only **$39.85**

AMPROBE JR.

The advanced voltage tester that gives you current, too. Available in seven models, ranging from 10 amps to 100 amps in either 125/250 or 150/600 volts. Choose the model that fits your job. *Only* **$19.85**

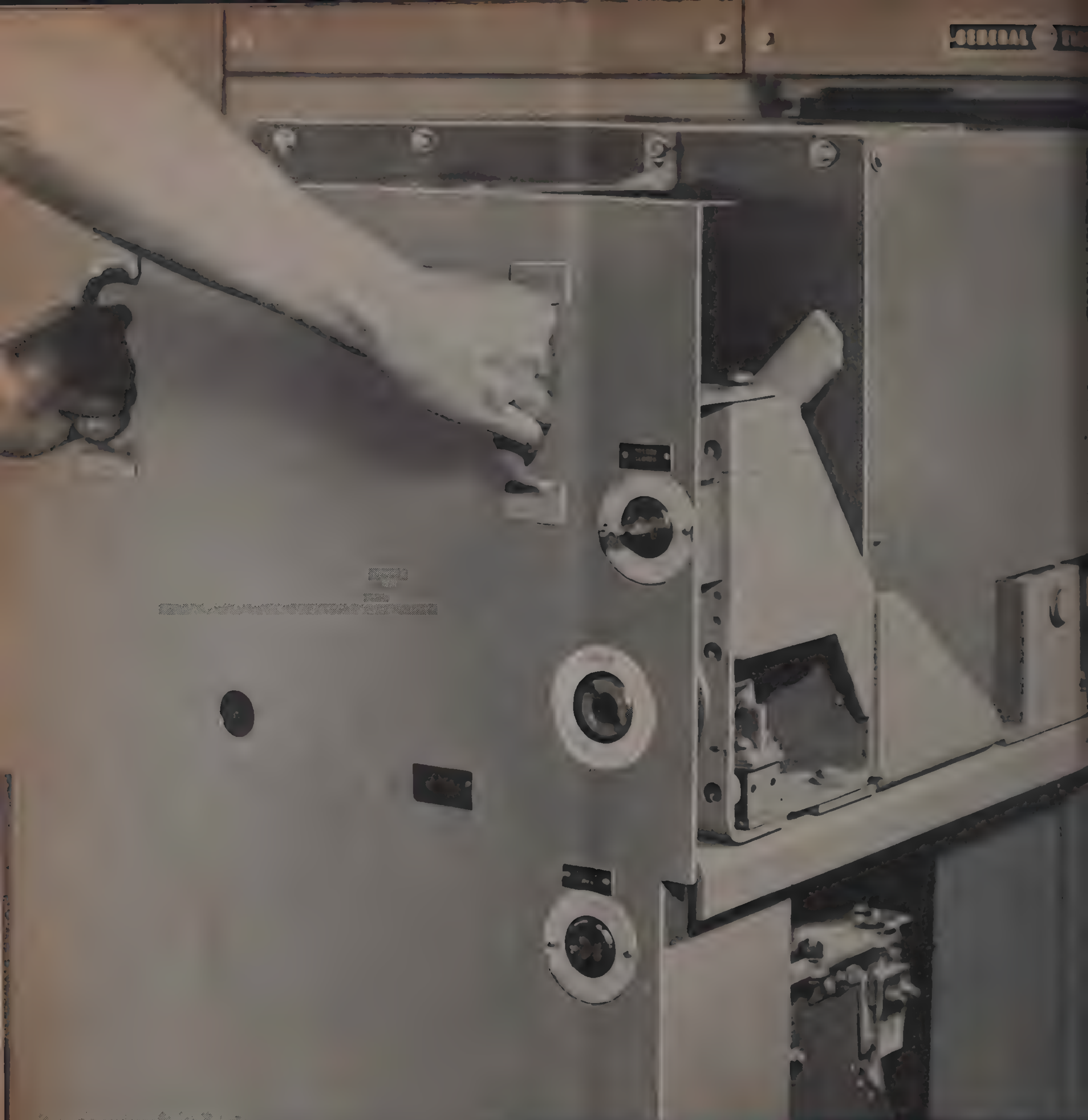
AMPROBE DECA-TRAN

Makes your Amprobe the world's most flexible and versatile electrical test instrument. Extends amperage reading 10 times. Gets readings as high as 1200 amps. *Only* **$24.75**

AMPROBE ENERGIZER

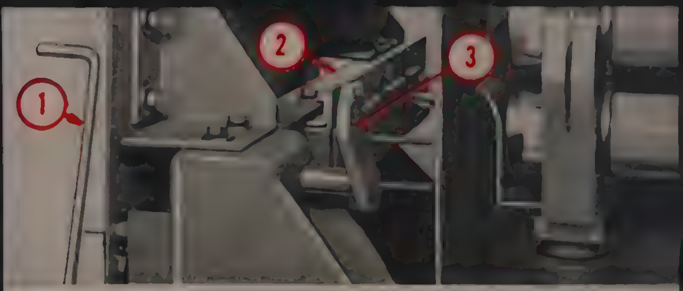
Multiplies the sensitivity of any Amprobe ten times—for precise readings on small appliances and fractional horsepower motors. *Only* **$3.75**

PYRAMID INSTRUMENT CORPORATION, LYNBROOK, N. Y. WORLD'S LARGEST MANUFACTURER OF SNAP-AROUND VOLT-AMMETERS.

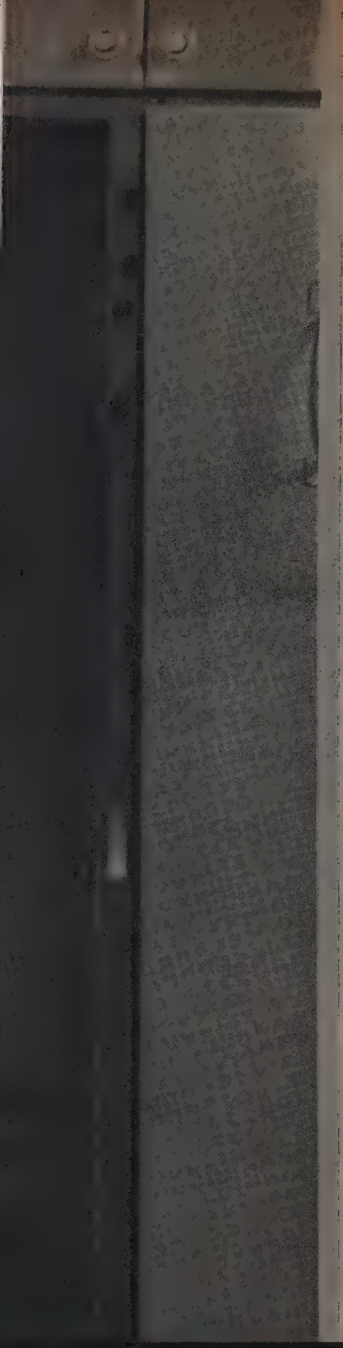


AS ACCESSIBLE AS A FILE DRAWER, G-E Roll-out Switch and Fuse Equipment (available in 2.4 to 13.8 kv ratings) combines maximum safety with ease of inspection and maintenance.

GREATER SAFETY



YOU GET GREATER SAFETY because (1) new, removable, single-stroke handle "charges" the operating spring safely, easily. (2) High speed closing and consistent contact opening are provided by one spring which works independently of operator. (3) Positive interlock gives greater safety for operator and equipment.



Here's how General Electric Rollout Switch and Fuse Equipment makes...

TH BIG DIFFERENC

in reducing fixed and operating costs for light duty switching and circuit protection

Greater safety, better short-circuit protection, easier installation, and reduced maintenance—these are the features of General Electric Rollout Switch and Fuse Equipment that play an important role in reducing your fixed and operating expenses.

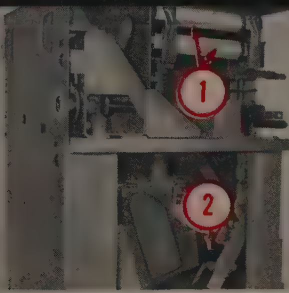
Precision-engineered components make another "Big Difference." A new manually-operated, stored-energy load-break switch provides both high-speed closing and consistent, sure contact opening independent of the operator. High quality current-limiting fuses and interrupter switches help assure rapid, sure switching and fault current protection.

Evaluate for yourself the difference this equipment can make in both commercial and industrial systems. For all the facts, contact your nearest G-E Apparatus Sales Office or write for bulletin GEA-6623B, General Electric Co., Schenectady 5, New York. 514-06

Progress Is Our Most Important Product

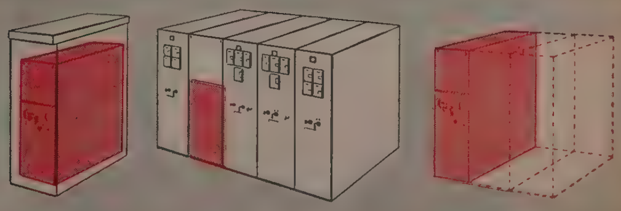
GENERAL ELECTRIC

ETTER SHORT-CIRCUIT PROTECTION



GENERAL ELECTRIC ROLLOUT SWITCH AND FUSE EQUIPMENT has (1) current-limiting fuses on the source side of the (2) load-break switch. This feature means you get greatly improved short-circuit protection.

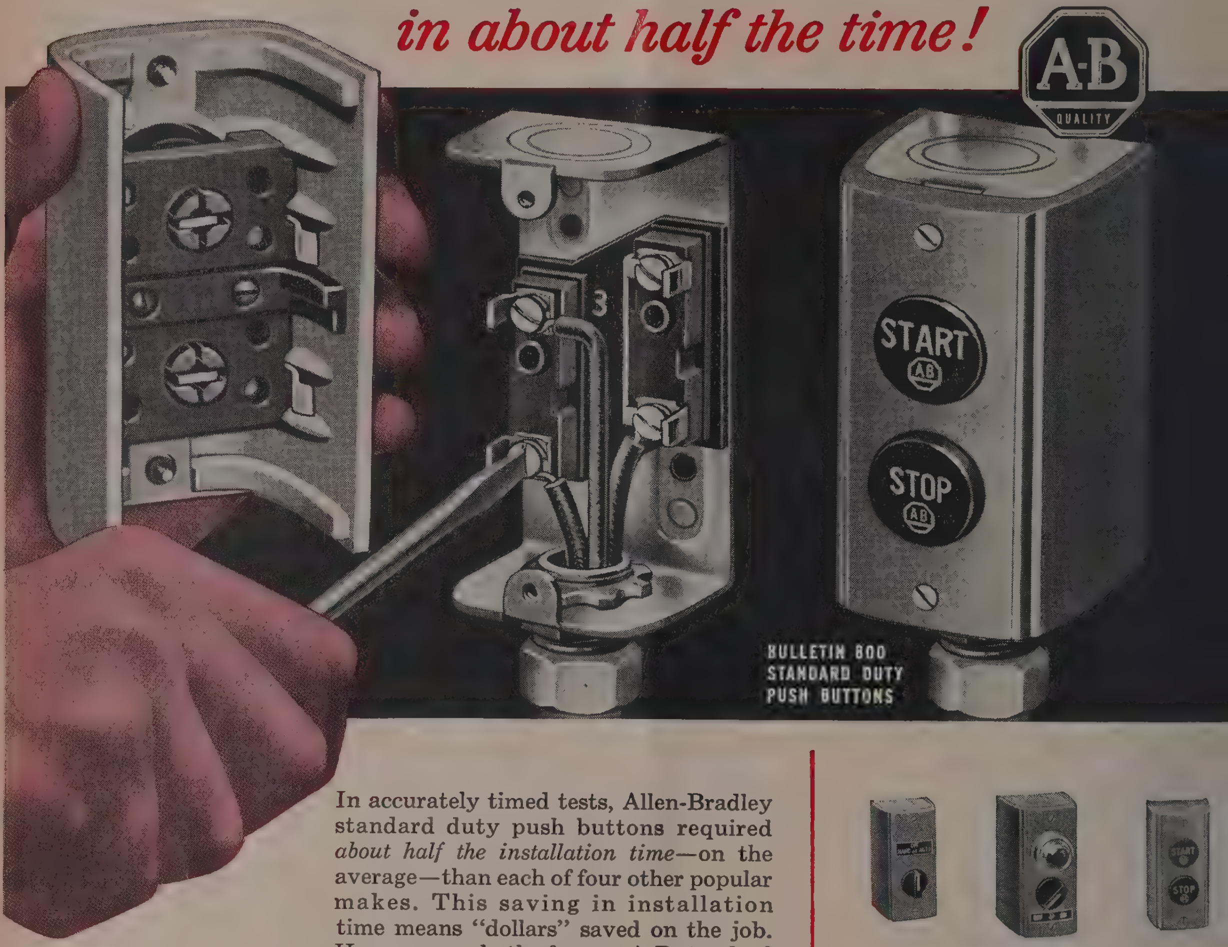
GREATER INSTALLATION VERSATILITY



YOU HAVE A CHOICE of construction types. G-E Rollout Switch and Fuse Equipment can be furnished to suit your installation needs—indoor or outdoor units; in line-up with G-E Metal-clad Switchgear; or in single or multiple units.

ACTUAL TESTS* PROVE

Allen-Bradley Standard Duty Push Buttons can be installed *in about half the time!*



BULLETIN 800
STANDARD DUTY
PUSH BUTTONS

In accurately timed tests, Allen-Bradley standard duty push buttons required *about half the installation time*—on the average—than each of four other popular makes. This saving in installation time means "dollars" saved on the job.

How come only the famous A-B standard duty push button possesses this time and moneysaving advantage? The answer lies in the molded, wrap-around cover—which also contains the contacts. When the cover is removed, the wiring terminals are *out in the open*—ready for wiring—and you have plenty of working space. The two cover screws are captive—they cannot fall out and get lost. And with the contacts in the cover, they are protected against accidental damage and careless wiring. Naturally, these push buttons have double break, silver contacts that never need service attention. There are two concentric knockouts on each end of the base, which are removed from the *outside*—the heavy, pressed steel base will not bend out of shape.

Your local A-B distributor has these Bulletin 800 push buttons *in stock*. Call him today—you'll save time and money on your next job.

**Using recognized standard duty push buttons, installations were made by an experienced electrician under identical conditions. He was not connected with Allen-Bradley Company in any manner.*

A-B STANDARD DUTY PUSH BUTTONS
Made as a one-, two-, or three-unit station—with pilot light available. Readily changed for horizontal or vertical mounting. Convertible two- or three-way selector switch supplied with or without pilot light.

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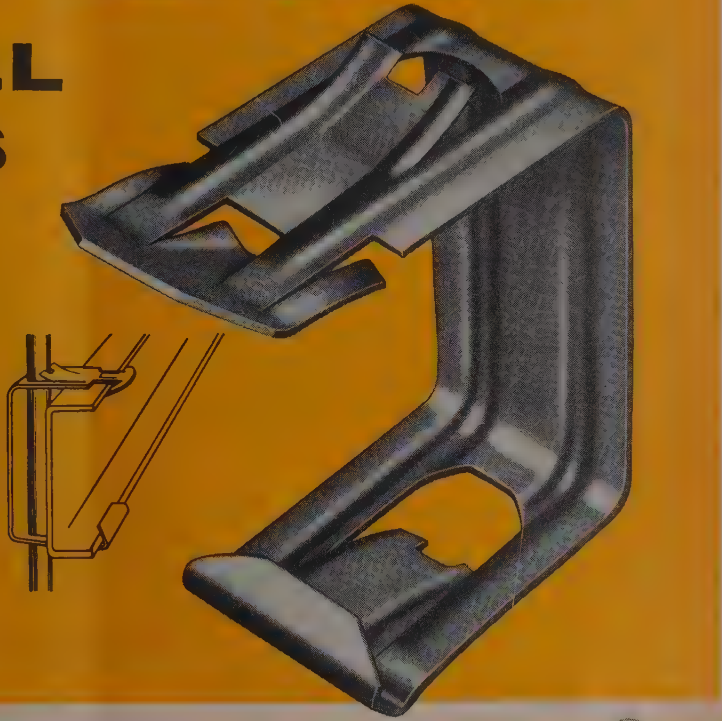
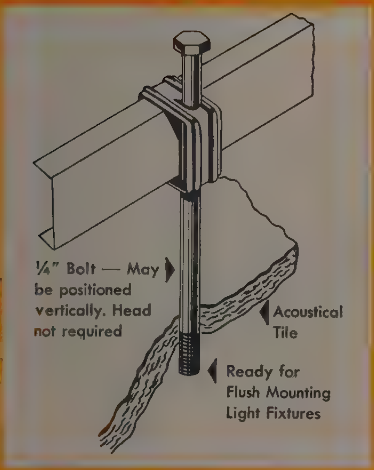
Allen-Bradley Co., 1307 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

QUALITY MOTOR CONTROL

introducing GAT®

CHANNEL CLAMPS

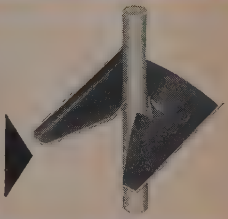



¼" Bolt — May be positioned vertically. Head not required
Acoustical Tile
Ready for Flush Mounting Light Fixtures

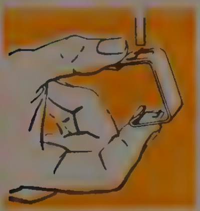
Over 5000 GAT Channel Clamps were used recently on one installation of a new building at the University of Minnesota. The Clamps suspend the fluorescent fixtures from the lather's channel (see drawing).

A cost saving of 50% was realized over former method, consisting of two drilling operations plus bolting in place. No other method provides the quality of installation at such a greatly reduced cost.

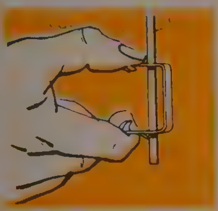
Plain ¼" or ⅜" rod may be used together with the GAT Fixture Clip to further reduce cost over the threaded bolt method illustrated.



how it works

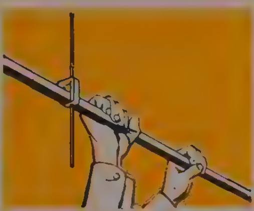


No tools required for installation. Clamp is compressed between thumb and forefinger and installed on rod as illustrated.

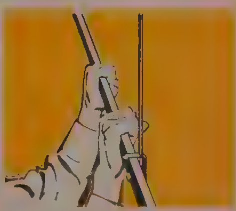


For adjustment, clamp is compressed and moved to desired position. When fingers are released, built-in tension locks clamp to rod.

Only one man is required to install channel when using **GAT** *CLAMPS.*



Bottom flange of channel is placed in lower lip of **GAT** *CHANNEL CLAMPS.*



Channel is rolled in against rod. Upper flange of channel will "snap" under top lip of **GAT** *CHANNEL CLAMP* and is locked securely in place.

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FASTENER PRODUCTS DIV.

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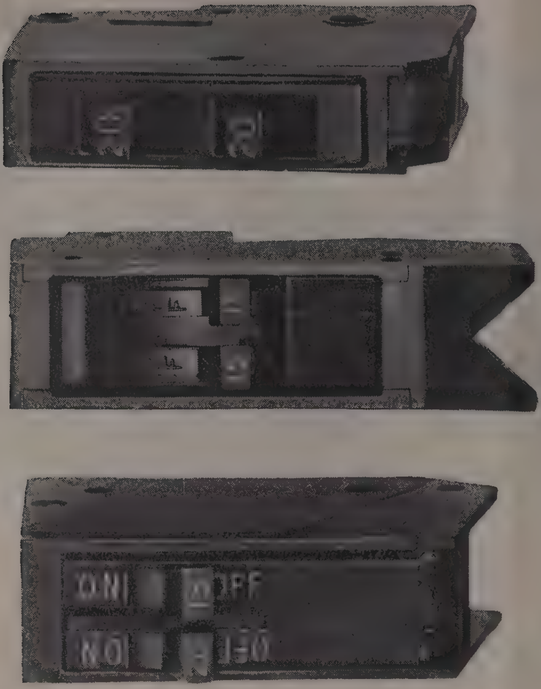

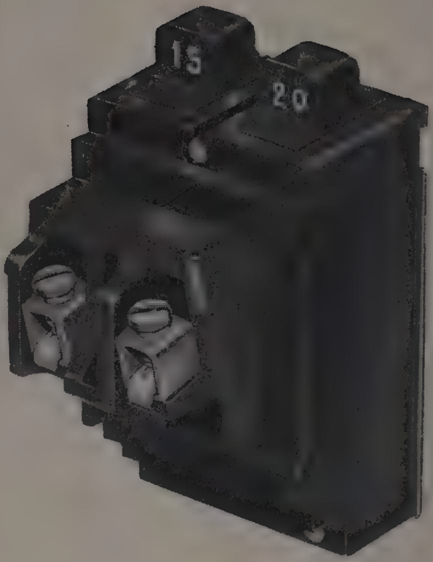

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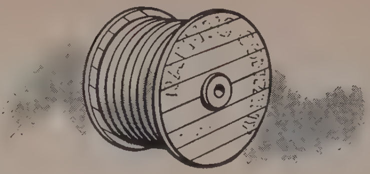

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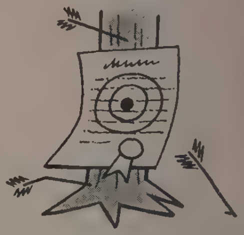

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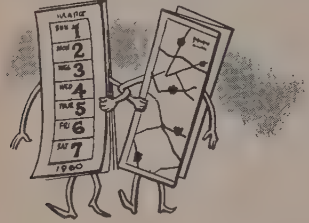

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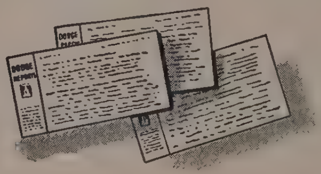

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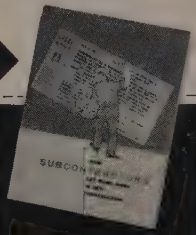

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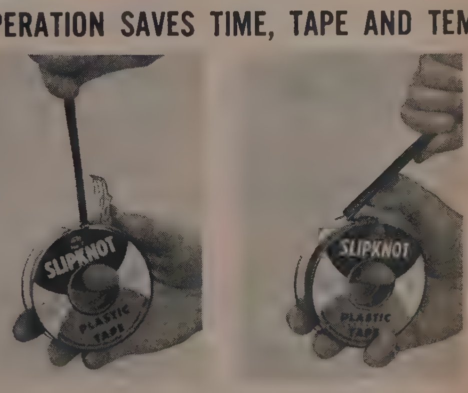

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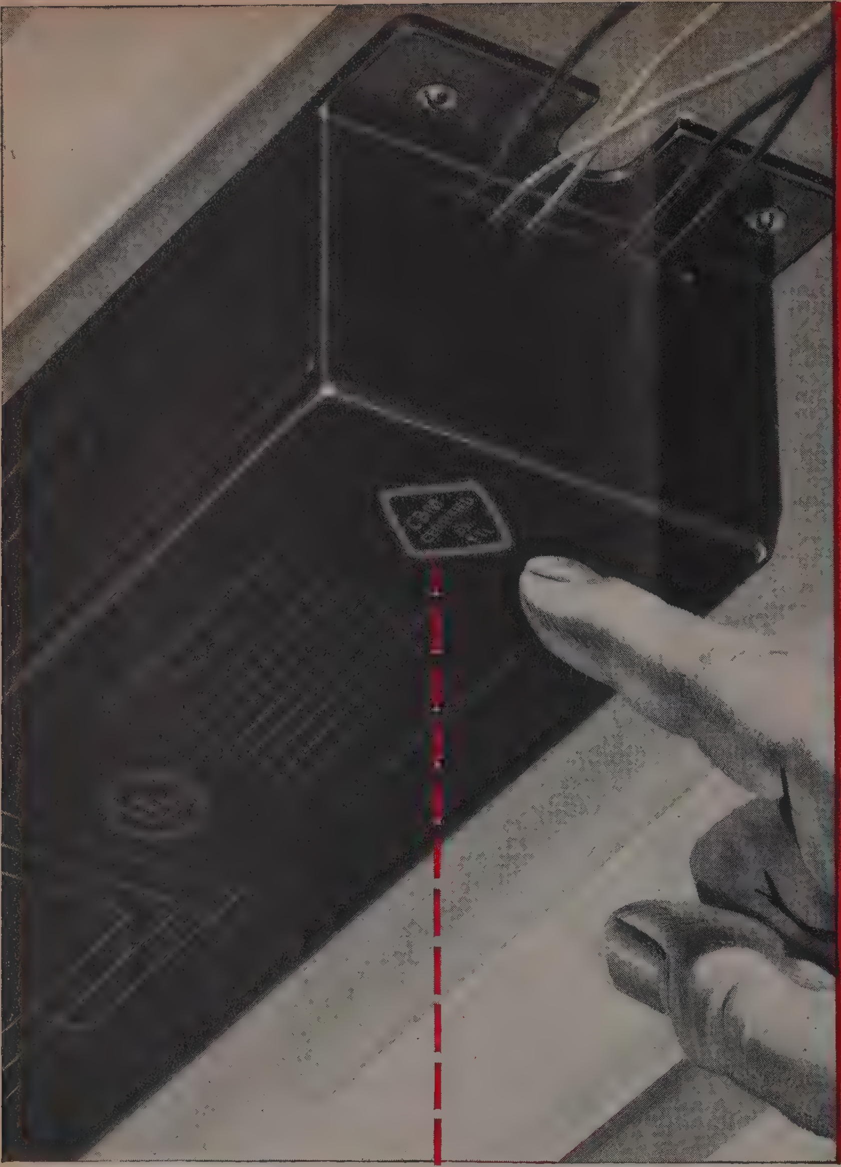

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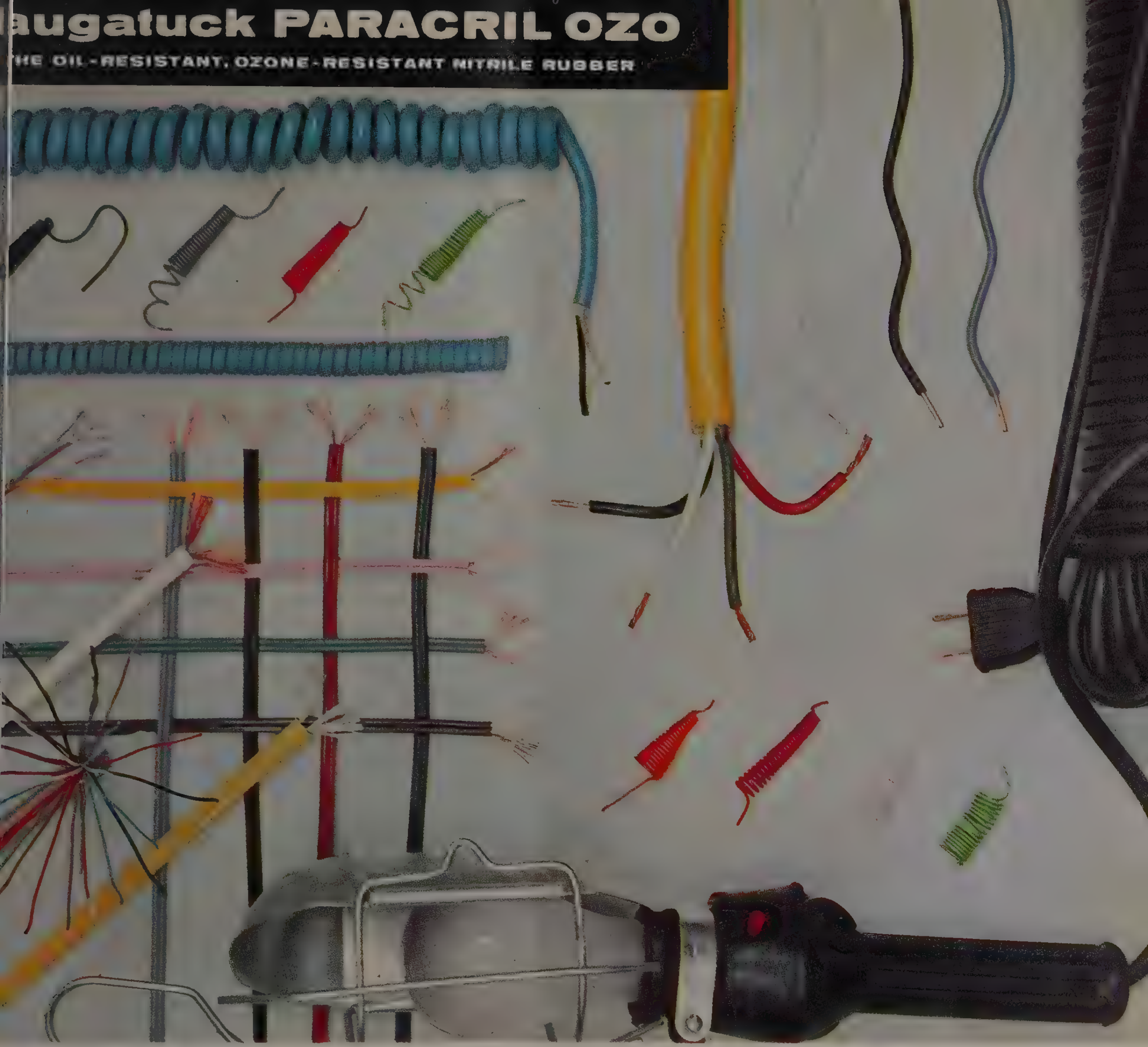

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A NEW.....
G&W CUTOUT BOX

for more economical and simplified fusing and switching installations

The new G&W Type BZ box design for mounting gang-operated oil-filled cutouts offers significant advantages for both indoor and outdoor nonsubmersible installations. This general-purpose box is compact, lightweight, easily installed, and economical. It is drip-proof, splashproof, and moisture resistant — conforming to NEMA standards for such applications.

Four knockouts, one at each end and two at bottom, provide flexibility in selecting points of cable entry at the installation site. Welded seams and gaskets under cutout flanges and front cover add to weather tightness and strength. Bottom ground lugs permit side-by-side mounting, flush wall mounting, or other means of support.

G&W Type BZ Cutout Boxes are constructed of No. 10 gauge steel; light enough for easy, economical installation yet durable enough for many years of trouble-free service. The new box design is made in three sizes to accommodate G&W FC31, FC42, or FC61 cutouts rated 2.5, 5, and 8kv.

The Type BZ box is another example of the constant improvement being made by G&W in cable accessories and switchgear engineered and designed to meet the growing needs of distribution. This improvement is based upon intimate knowledge of industry requirements gained over the past 55 years. Your G&W Representative is particularly well qualified to consult with you on cable fusing and termination problems. G&W's unique engineering service is also available to assist you in meeting even the most specialized needs.

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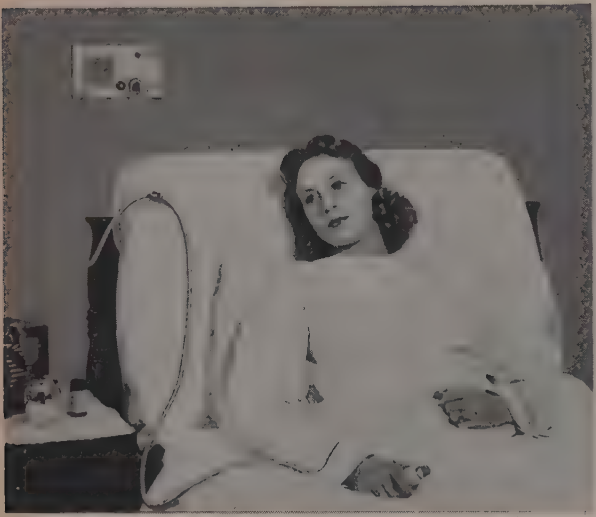

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The name AUTH on electrical signaling, time, and communication equipment conveys different meanings, all of which can be summed up in one word—profit!

To owners—and their representatives, the architectural and engineering firms—Auth stands for capable assistance in planning requirements, excellent product performance, and minimum upkeep.

To distributors, Auth means easily-consumated orders at the right price—without rejections, delays, or excess paperwork.

To installing contractors, Auth represents well-made, dependable equipment specifically designed to simplify installation. They hook it up and walk away!

Everyone profits when fine equipment—as made by Auth—is specified, purchased, and installed.

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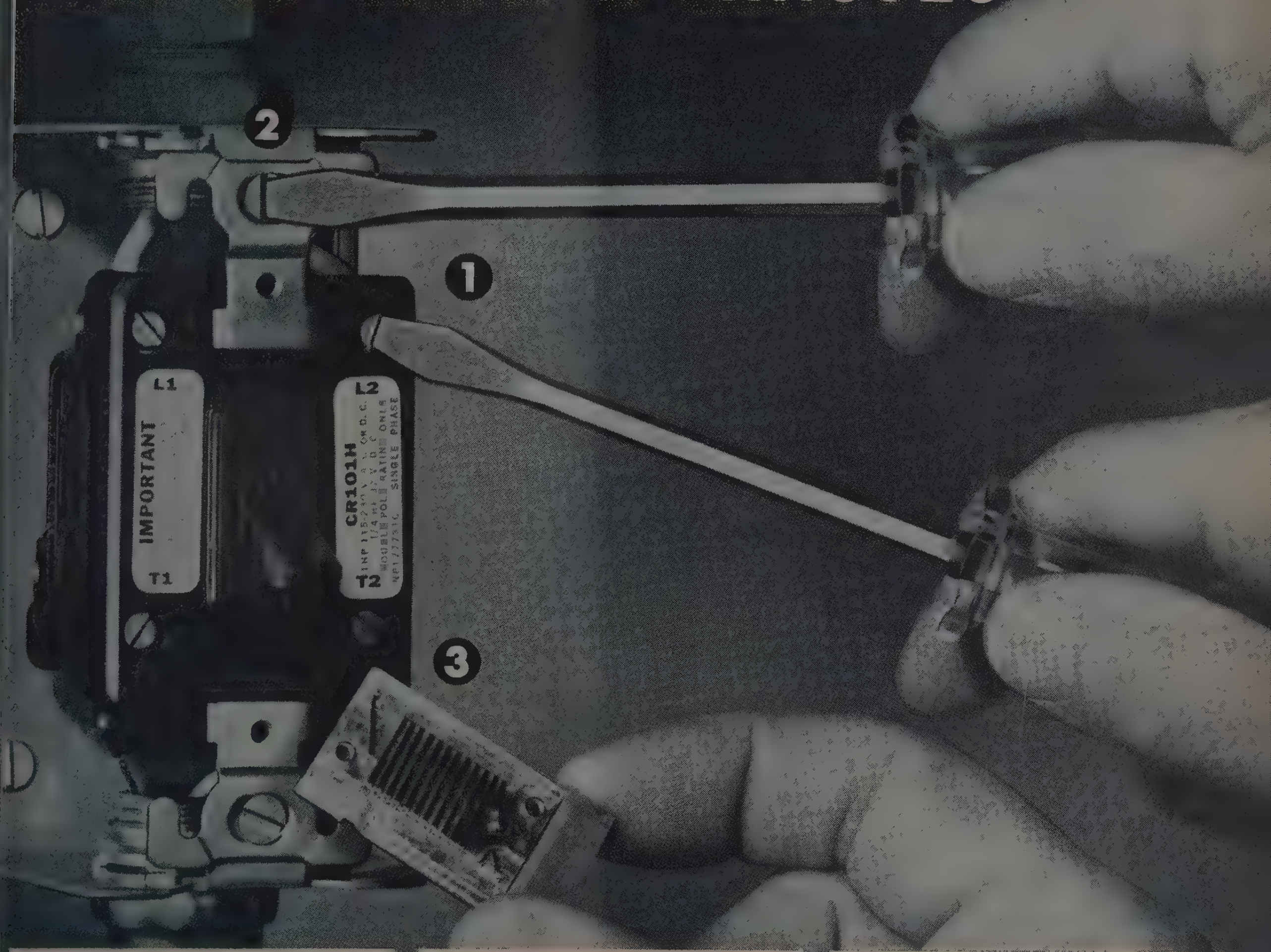
LONG ISLAND CITY 1, NEW YORK

SPECIALISTS IN ELECTRICAL SIGNALING AND COMMUNICATION SYSTEMS AND EQUIPMENT

HOOK-UP TIME: 2 MINUTES



① Once G-E manual starter enclosure has been mounted on wall or machine, strip wires, insert in pressure-type terminals and tighten terminal screws. No looping necessary. All line terminals are at top, load terminals at bottom.

② Position open starter in enclosure and tighten two screws. With wrap-around enclosure cover removed, maximum working room is provided. Compact design of the CR101 manual starter means easier handling, greater wiring space.

③ Mount heater. Exclusive design plugs in from front in 3 seconds and is keyed to eliminate chance of incorrect insertion. Ampere trip rating is molded on front of heater. Enclosure cover can be replaced by tightening two screws.

KIT PACKAGING of starter components provides 24 combinations. Included are key-operated starters and stainless steel flush plates shown above.

General Electric CR101 Manual Starters Offer Unmatched Installation Convenience and Flexibility

Just 2 minutes to hook up the General Electric CR101 fractional hp manual starter. Multiply this advantage times the number of starters you install every year, and count your dollar savings.

And you can get the exact starter you need from General Electric—any combination of these components: standard or key-operated open starters; single- or two-gang back boxes; standard cover; and wide choice of flush plates—machine grey or stainless steel, for single- or two-gang installations, with or without indicating light. Components are packaged in kits to save more installation time. No disassembly is required before wiring.

Next time you buy manual starters, try the G-E CR101. Ask your nearby G-E distributor for GEA-6358 and GEA-6976 or write General Electric, Schenectady 5, N. Y. 812-01

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WITH GENERAL ELECTRIC CONTROL

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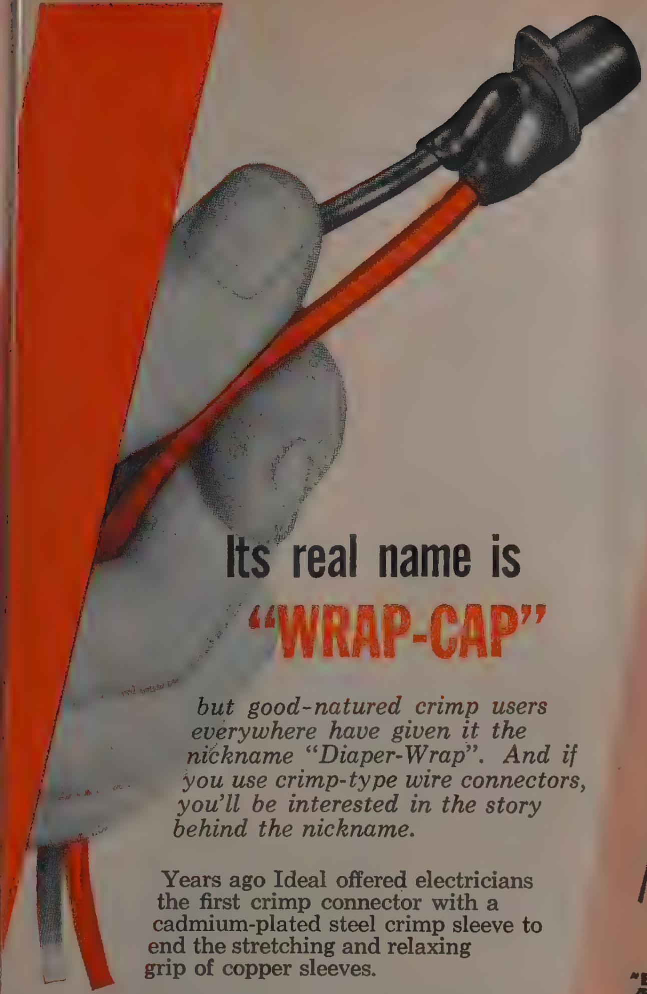

Its real name is "WRAP-CAP"

but good-natured crimp users everywhere have given it the nickname "Diaper-Wrap". And if you use crimp-type wire connectors, you'll be interested in the story behind the nickname.

Years ago Ideal offered electricians the first crimp connector with a cadmium-plated steel crimp sleeve to end the stretching and relaxing grip of copper sleeves.

But something *else* was needed: a *better* way to insulate the joint. So we worked to develop a method that *combined* the simplicity of a pre-formed cap with the snug fit of a tape wrapping . . . yet with none of the disadvantages of either.

Our answer was the "Wrap-Cap" insulator, molded in just one piece of tough reinforced vinyl. It's the greatest . . . and the easiest! After you crimp your wires, just slip "Wrap-Cap" over the crimp; pull it down; under and between the wires; then over the top like a cap. That's it! . . . the form fitting "diaper-wrap" that insulates *between* the wires. It's so easy, yet you have the neatest, most compact, and best-insulated crimp connection you can make. And notice the *double* thickness over the end of the crimp. U.L. lists "Wrap-Cap" for General Use (600V) in branch circuit and fixture wiring.

Now here's our offer. Prove to yourself that the Ideal Crimp and "Wrap-Cap" is the one you should use. Mail the coupon today and we'll send you a few free samples to try.

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MADE BY IDEAL

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"FLEXI-STRAND", Ideal's new extra-flexible fish tape answers the problems of pulling wires around sharp bends. It is made of high quality preformed galvanized aircraft cable. It is more durable, and stronger, and will far out-last ordinary flat tapes. So flexible it will easily take a sharp bend in any conduit without cutting. Takes extreme flexing without kinking or taking a set. Extremely high breaking point of 2,500 lbs.

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Safest, easiest-to-use voltage tester made. Designed for rugged daily use. Case is seamless plastic in Safety Yellow, with no surface metal. Prods have extra-safe no-slip grips and 30" neoprene leads. Case has center mount for one prod, with prod storage space to completely shield tips. Test for: VOLTAGE (110 to 550v AC; 110 to 600v DC) FREQUENCY (25 to 60 cycles), AC or DC. Solenoid calibrated voltage indicator functions separately from neon test lamp for super-safety. Available with special current-limiting resistors in each prod.

"E-Z" AUTOMATIC HAND STRIPPER

Strips standard branch circuit, fixture and lamp wire, and all other stranded or solid wire. Automatic stop locks jaws open after stripping until wire is removed. Eliminates crushed wire ends. Available with eccentric adjustment on blades to limit cutting depth.

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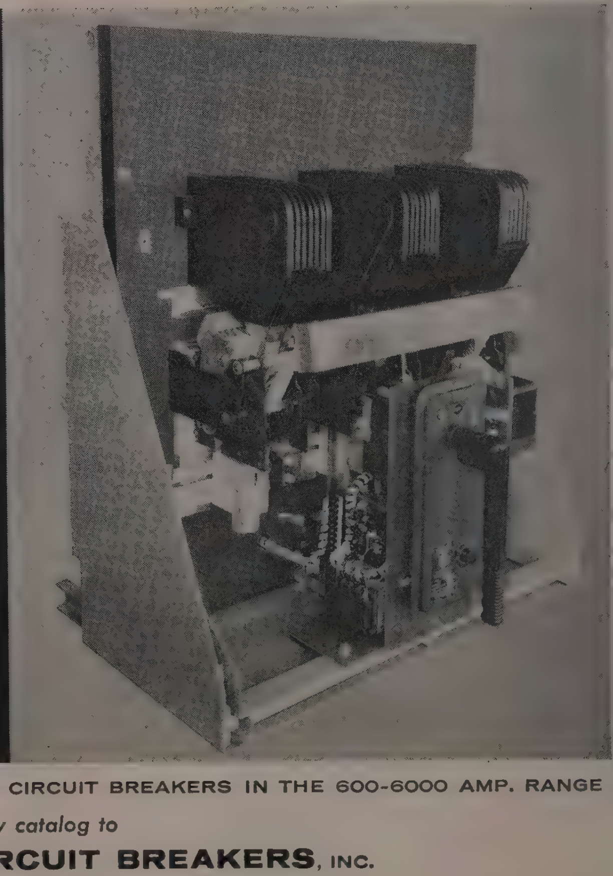

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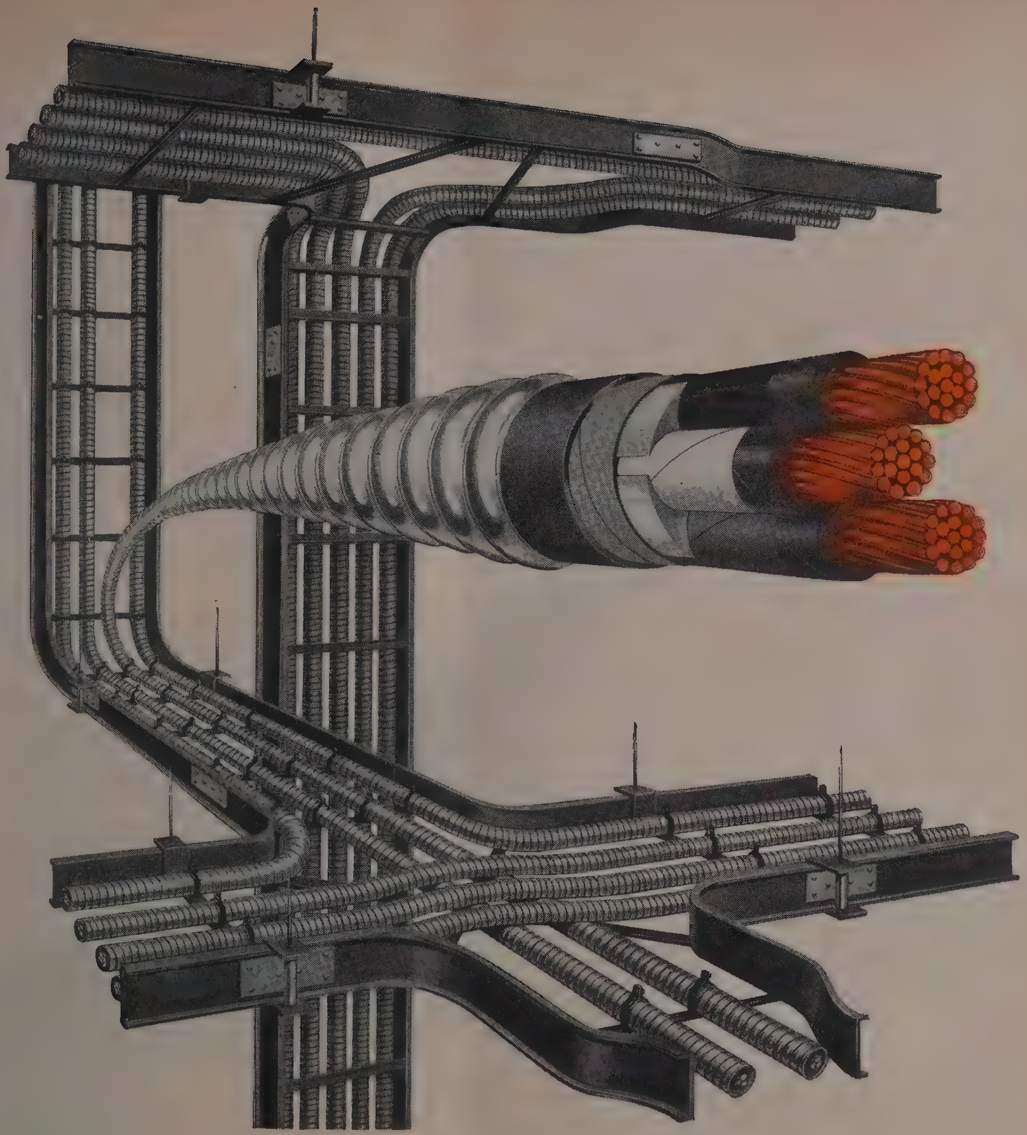
P. O. Box 3798, Portland 8, Oregon



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CORPORATION
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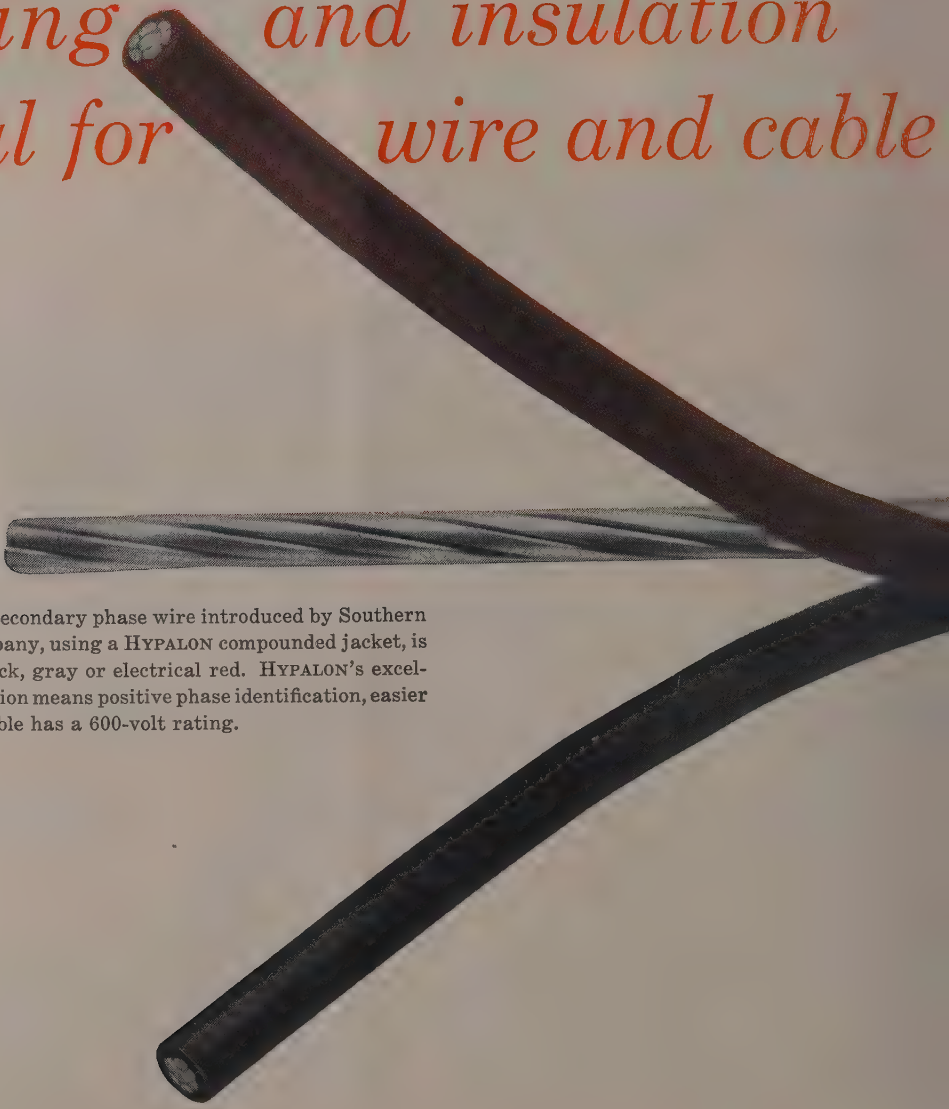
Another new development from Du Pont:

Hypalon® ... an improved jacketing and insulation material for wire and cable

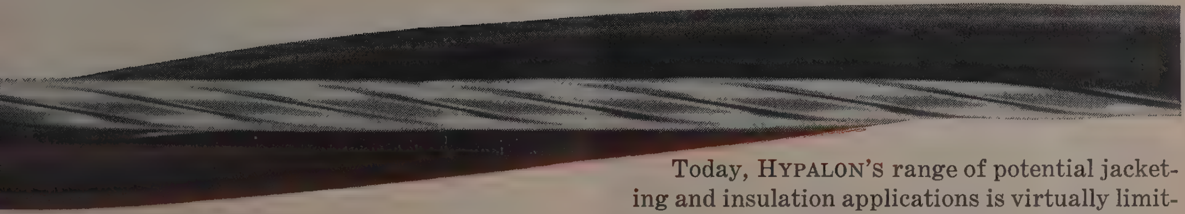


New insulated secondary phase wire introduced by Southern Electrical Company, using a HYPALON compounded jacket, is available in black, gray or electrical red. HYPALON's excellent color retention means positive phase identification, easier tap-in. New cable has a 600-volt rating.

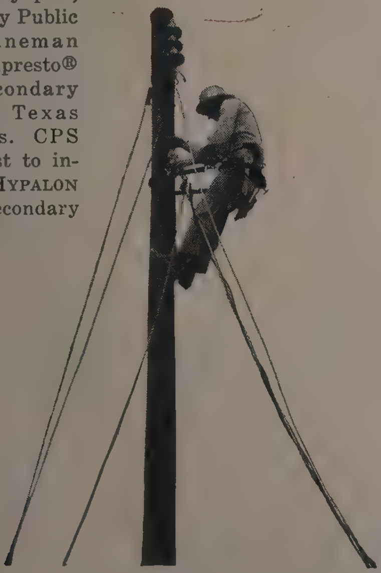
New synthetic rubber combines excellent mechanical and aging properties...permits color coding of high-performance triplex secondary cable

The key improvement in this new triplex secondary cable is jacketing and insulation of tough, weather-resistant Du Pont HYPALON. Designed to meet the requirements of increased power consumption—brought on by a growing population and heavier industrialization—the cable relies on new Du Pont HYPALON synthetic rubber to provide a combination of properties found in no other jacketing material.

For example, HYPALON's permanent colorability now permits color coding of secondary network cable for positive phase identification. Its exceptional resistance to heat and flame assures safe, dependable operation during periods of severe electrical overload. HYPALON's outstanding resistance to weather, aging, ozone, sunlight, abrasion, oil and chemicals means long life and economical performance under every condition encountered in rugged line service. And HYPALON's electrical properties permit a single extrusion to act as both insulation *and* jacket . . . resulting in a significant reduction in wall thickness.



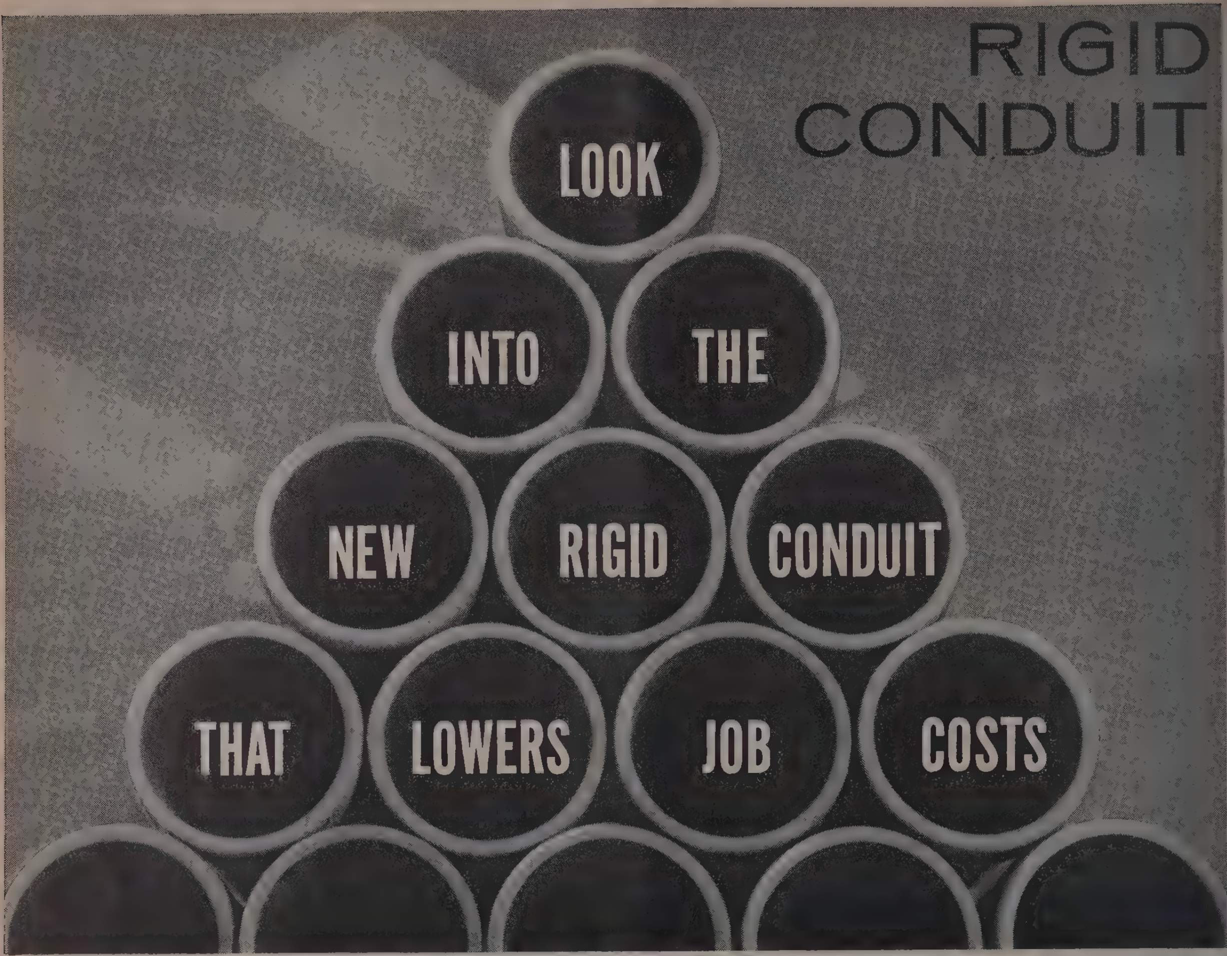
Today, HYPALON'S range of potential jacketing and insulation applications is virtually limitless. On service drop wire, it meets the highest requirements for insulation . . . provides needed resistance to burning or flowing at high temperatures. Other potential uses include spaced aerial cable (rated at 15 KV and up), direct burial power cable, automotive wire, mine trailing cable, building wire and appliance cord. Explore the many ways HYPALON jacketing and insulation can improve performance of the cable you use. For information, write E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. ECM-8, Wilmington 98, Delaware.



Atop a utility pole, a Community Public Service lineman strings Compresto® triplex secondary wire near Texas City, Texas. CPS was the first to install new HYPALON jacketed secondary cable.

HYPALON®
SYNTHETIC RUBBER

DU PONT
REG. U. S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry



New, from Harvey Aluminum—an easier-to-handle aluminum rigid conduit. High quality conduit in a complete range of standard sizes. The result of years of research to produce a special aluminum alloy—an alloy that gives the electrical industry all the desirable qualities needed for maximum conduit efficiency.

Harvey Aluminum Rigid Conduit offers the exclusive advantages of aluminum conduit over ordinary conduit—light weight, corrosion resistance, consistent attractive appearance, lower handling costs, nonsparking, and nonmagnetic. It is shipped with color-coded thread protectors to shield threads and speed up storage and handling. It makes wire pulling easier because all internal surfaces are uniformly treated and coated during manufacturing by an automatic device. Threads on both ends of all lengths and elbows have a special lubricant. All elbows have uniform cross-section.

Priced competitively with ordinary conduit, Harvey Aluminum Rigid Conduit improves performance and reduces handling and installation costs. Every section carries the Underwriters' Laboratories label of approval; meets and beats the specifications of the code on rigid conduit. Available right now *at established electrical supply distributors exclusively.* For additional details, write Harvey Aluminum, Torrance, California.

HARVEY
Aluminum

A primary producer of quality aluminum in all alloys and sizes: Pig, ingot, billet, rod and bar, pipe, tube, hollow sections, press forgings, forging stock, hand forgings, impact extrusions, electrical bus bar, rigid conduit, structurals, special shapes, light and heavy press extrusions, screw machine and other aluminum products. Related products in titanium, zirconium, steel. Harvey Aluminum Sales, Inc., Torrance, California

New L-M Lawn-Glo Lights Designed for Many Markets; Offer Good Profit

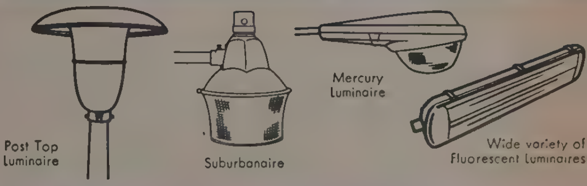
The LAWN-GLO line is suitable for subdivisions, parks, swimming pools, motels, restaurants, recreation areas, homes, private estates, and public grounds, where these lights enhance landscaping day and night.

LAWN-GLO lights are available in seven handsome colors; photo-control if desired. Rust proof. Post-top unit is 25″ wide and 35″ high from post-top to socket cap. For lamps up to 150 watts. Convenience outlet in slip-fitter base. Sold only through electrical distributors.

Line Material's line of LAWN-GLO lights consists of attractive, efficient units designed for applications where smart appearance and soft lighting are desired. This light is but one of the several excellent units designed and manufactured by Line Material Industries, a leading manufacturer of outdoor lighting and outdoor electrical distribution equipment.

L-M offers electrical contractors an unusual opportunity to provide their customers with high-quality outdoor lighting equipment. We provide excellent products, dependable service, sales literature, national advertising, and outstanding Lighting Application Engineering Service. For information, ask your electrical wholesaler. He can help you solve your outdoor lighting problems. If he does not carry L-M's lighting equipment, ask him to get in touch with us; or mail the coupon and send us his name.

OTHER L-M LIGHTING UNITS



LINE MATERIAL® Industries

McGRAW-EDISON COMPANY

Outdoor Lighting

MORE THAN 10,000 PRODUCTS
FOR OUTDOOR LIGHTING AND POWER DISTRIBUTION

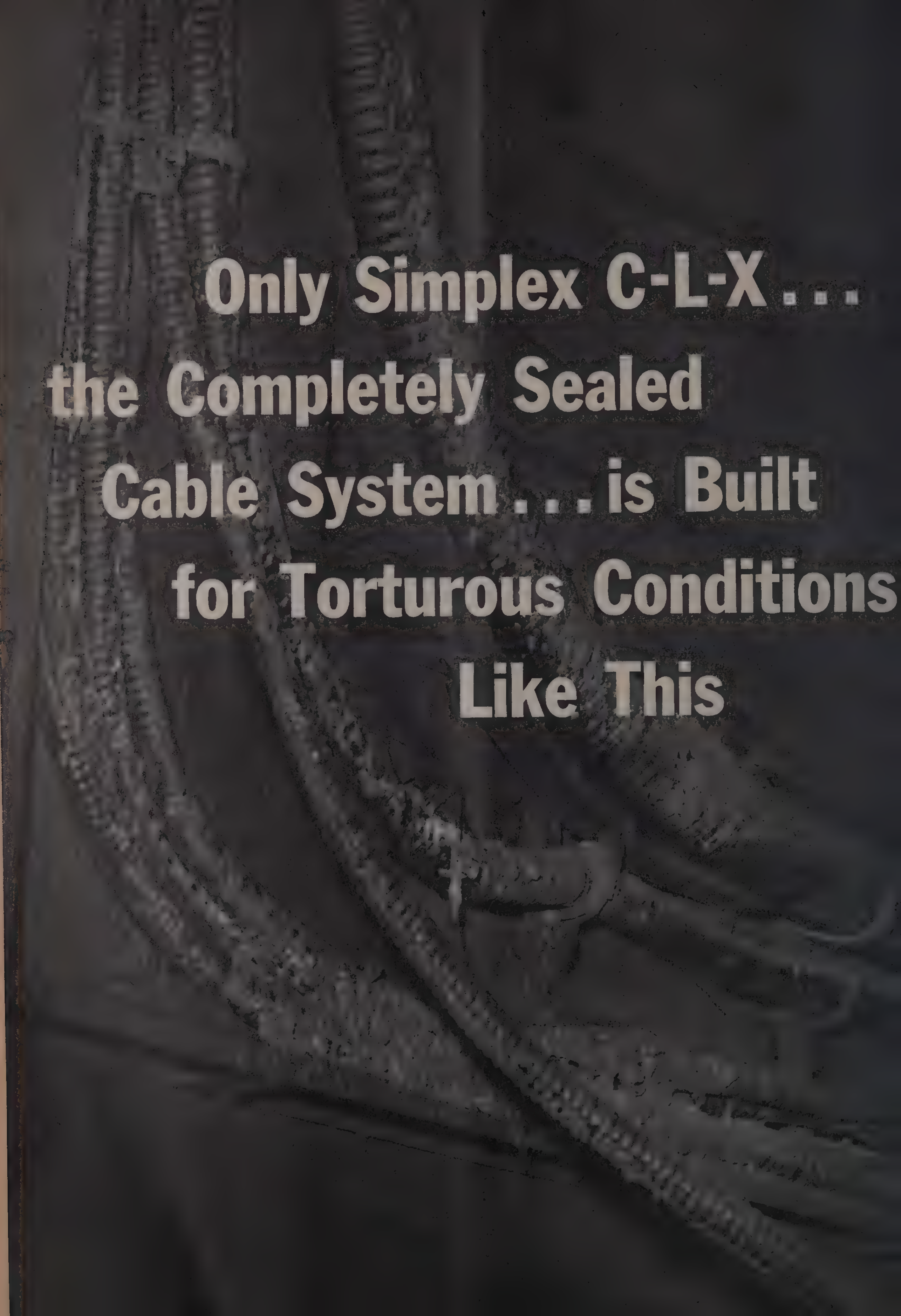
DISTRIBUTION TRANSFORMERS · RECLOSERS, SECTIONALIZERS AND OIL SWITCHES
FUSE CUTOUTS AND FUSE LINKS · LIGHTNING ARRESTERS · POWER SWITCHING EQUIPMENT
PACKAGED SUBSTATIONS · CAPACITORS · REGULATORS · OUTDOOR LIGHTING
LINE CONSTRUCTION MATERIALS · PORCELAIN INSULATORS · FIBRE PIPE AND CONDUIT

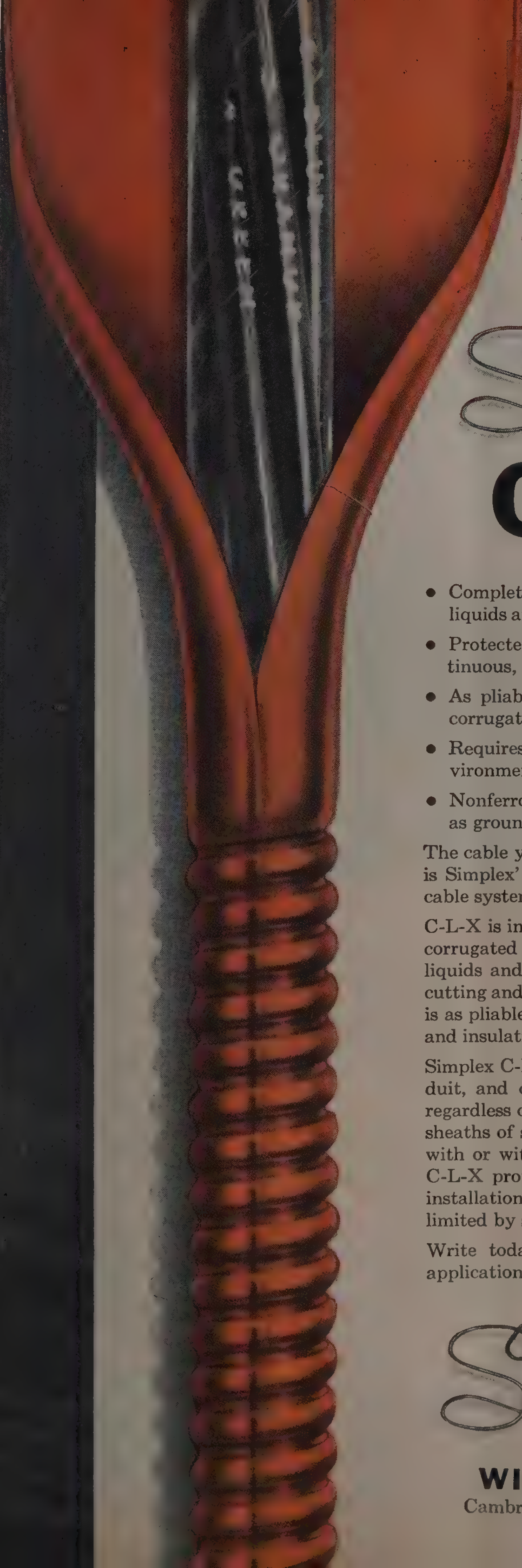
MAIL THIS COUPON

Line Material Industries, Lighting
Division, Milwaukee 1, Wisconsin

ECM 80

☐ Please send me L-M's Outdoor Lighting Bulletin
My Electrical Distributor is
(name of distributor)________
City________
Your Name________
Title________
Company________
Address________
City________ State________


Only Simplex C-L-X . . .
the Completely Sealed
Cable System . . . is Built
for Torturous Conditions
Like This



Simplex C-L-X combines cable and duct in one integrated system

Metal, in the form of a continuous flat strip, is formed into a welded tube around the insulated cable. The metal tube is then corrugated to form Simplex C-L-X.

Simplex C-L-X

- Completely sealed to prevent penetration of liquids and gases.
- Protected against mechanical damage by a continuous, corrugated metallic sheath.
- As pliable as unsheathed cable because of its corrugated design.
- Requires no separate duct or conduit in any environment.
- Nonferrous sheaths can be designed to function as grounds or shielding.

The cable you see here is *not* interlocked armor. It is Simplex' new C-L-X . . . the completely sealed cable system.

C-L-X is insulated cable enclosed in a continuous corrugated metallic sheath. It is impervious to liquids and gases, is highly resistant to crushing, cutting and other forms of mechanical damage, and is as pliable as unsheathed cable of the same size and insulating compound.

Simplex C-L-X requires no separate duct or conduit, and can be installed in a continuous run regardless of the number of bends. Available with sheaths of steel, aluminum, copper or bronze, and with or without outer plastic jacketing, Simplex C-L-X provides the ideal solution for almost any installation, particularly those in which cable life is limited by severe ambient conditions.

Write today for illustrated brochure containing application and engineering information.

Simplex

WIRE & CABLE CO.

Cambridge, Mass. • Newington, N. H.

Now . . . from the company that created the tapes used in the satellites . . .
MYSTIK
PLASTIC ELECTRICAL TAPE
No. 6407
MYSTIK
PRODUCTS, INC., CHICAGO 39 • PLASTIC

MYSTIK BRAND

a plastic electrical tape of SUPERIOR QUALITY!

Mystik Brand Plastic Electrical Tape is made by the same company that introduced silicone adhesives—the company that created the hi-low temperature tapes used in the U. S. satellite and missile program. Here's a tape you *know* you can count on!

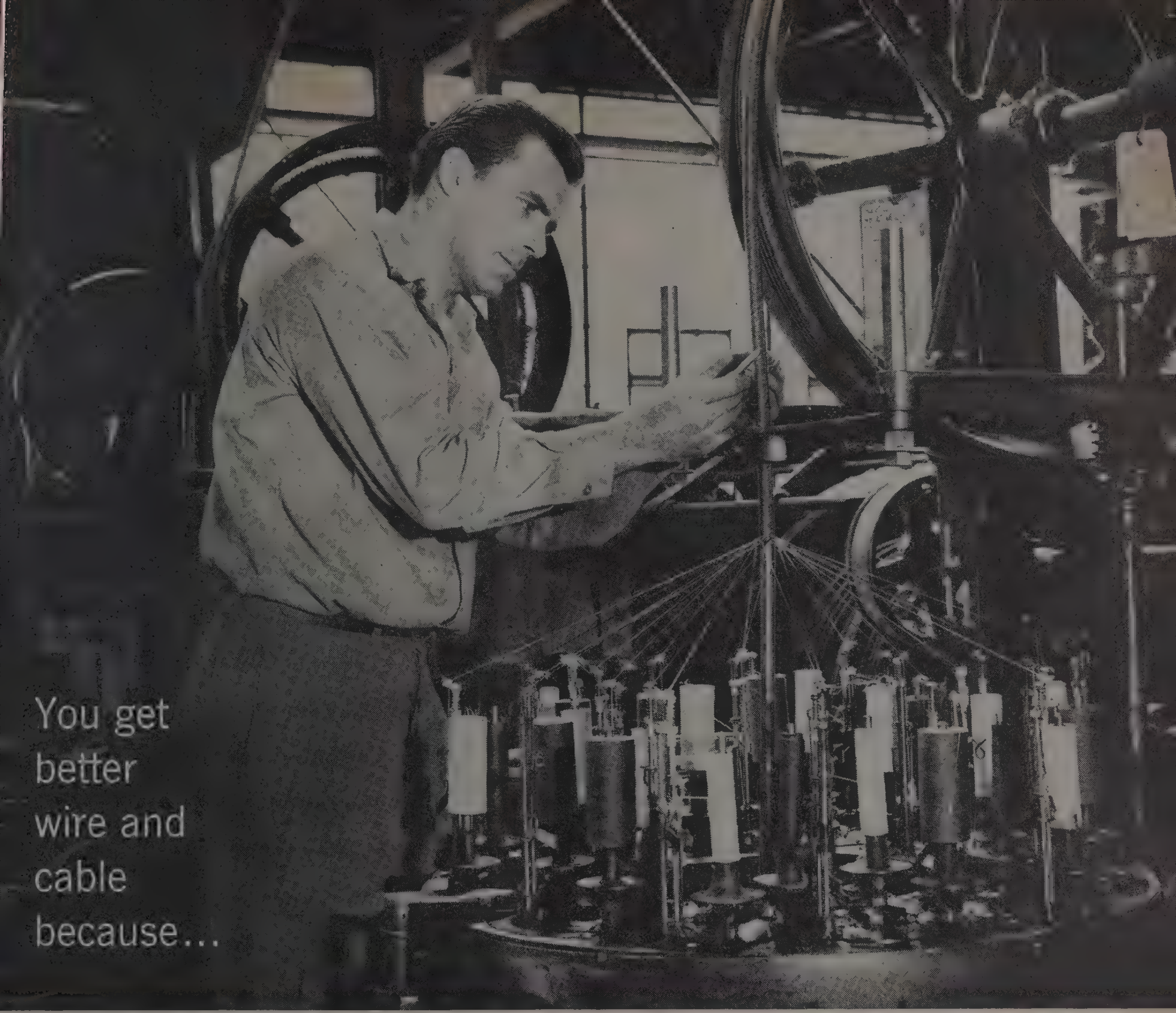
Mystik No. 6407 offers some important advantages you *ought to hear about.* It's easy to use—sticks quickly and conforms readily to irregular surfaces. Saves you taping time. No. 6407 offers high dielectric strength and laughs off oil, acids, alkalies, weather and wear. Seals tight as a drum—assures trouble-free performance on every job.

* * *

Call your electrical wholesaler today. Insist on Mystik Brand 6407 Plastic Electrical Tape—now packed in a handy, protective can. You'll always be glad you did!

MYSTIK ADHESIVE PRODUCTS, INC.
2635 N. KILDARE AVE. • CHICAGO 39

MYSTIK® BRAND



NEARLY EVERYONE AT CIRCLE'S AN "INSPECTOR"

Take Oscar Stangoni, braiding machine operator at Circle.

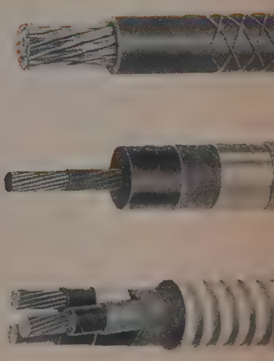
Mr. Stangoni doesn't need to use a micrometer. Ordinarily, his foreman sets up the machine, checks with a "mike" at the beginning of a run and several times during a run to make sure that the O.D. is OK.

But Oscar Stangoni uses one just the same—and he uses it often. Why? Maybe pride or a sense of responsibility—or maybe just because he feels better when he also knows the cable is absolutely right.

This is just one of many ways in which Oscar Stangoni and hundreds more like him at Circle make sure that the wire and cable they turn out is as good as it can possibly be.

And that's another reason, we believe, why Circle products have achieved their reputation for quality.

Next time you specify cable, we suggest you ask for Circle. There's no finer cable made. CIRCLE WIRE & CABLE CORP., Maspeth, N. Y.



CWC CIRCLE WIRE & CABLE
a subsidiary of
CERRO DE PASCO CORPORATION

RUBBER COVERED WIRE & CABLE • VARNISHED CAMBRIC CABLE • PLASTIC INSULATED CABLE • NEOPRENE SHEATHED CABLE • CIRTUBE* EMT

Photo courtesy of Aluminum Casting and Engineering Company, Milwaukee, Wisconsin

225 footcandles!

Abolite lifts the lighting level—This company makes intricate aluminum permanent mold castings. They wanted a higher level of lighting in their foundry to increase worker efficiency. They got it using Abolite fixtures in what some lighting engineers call the most outstanding mercury lighting installation in the country.

In the low-bay area, there's an average footcandle level of 225, yet there's no glare—both vertical and horizontal surfaces are lighted evenly without any deep shadows. The Abolite fixtures give 35° shielding to lamp, direct 18% of light upward through open top to wash out deep ceiling shadows.

Most important, this system costs less than a comparable fluorescent system because fewer fixtures are needed. Maintenance costs are less, too, because the chimney effect of Abolite's open-top design prevents dirt from collecting on lamp and reflector surfaces. Why not try this system with Abolite fixtures on your next job? For full information, write *Abolite Lighting Division, The Jones Metal Products Company, West Lafayette, Ohio.*

INSTALLATION DATA

Low bay—Twin-mounted Abolite HMFAU-1800 fixtures with 400 watt color-improved mercury lamps. Mounting height 14′, with 13′ x 12′ spacing. Average footcandle level: 225.

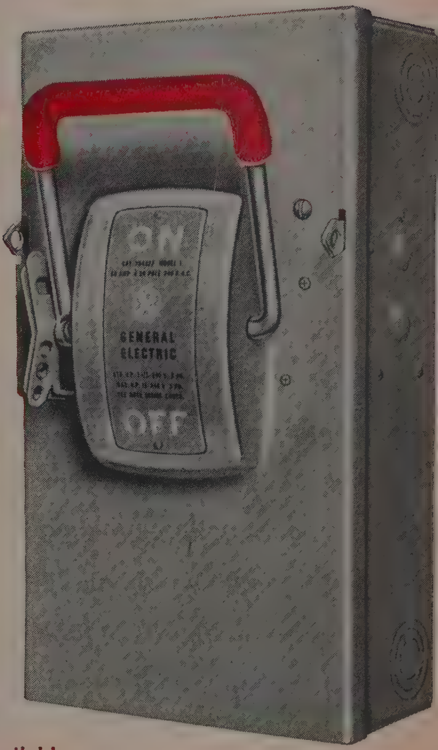
High bay—Abolite HMFAU-2400 fixtures with 1000 watt color-improved mercury lamps. Mounting height 24½′, with 13′ x 12′ spacing. Average footcandle level: 180.

Consulting Engineer:
Trester Engineering Co.
Electrical Contractor:
Bentley-Jost Electric Corp.

ABOLITE Lighting

THE JONES METAL PRODUCTS COMPANY
West Lafayette, Ohio

New General Electric Heavy Duty Switches safely withstand 200,000-amp. short circuit!



All new General Electric heavy duty (TH) and heavy duty interrupter (THD) safety switches were recently tested for short circuit operation with current limiting fuses at G.E.'s High Voltage Test Laboratory in Philadelphia. The results prove that both TH and THD switches will stand up under a 200,000-ampere short circuit when used with General Electric CLF* high interrupting capacity fuses or other current limiting fuses of comparable characteristics as defined in NEMA Standards FU1-1959. An independent engineering firm supervised the tests and certified all results.

General Electric Switches are rated 30 to 600 amperes, 240 to 600 volts, and are available in both NEMA 1 and gasketed 1A enclosures. See your G-E Distributor.

*TRADE-MARK

Typical 3 Phase Tests of G-E Heavy Duty Safety Switches at 200,000 Amperes Available

Type Switch	Average Available Symmetrical Amperes	Circuit Voltage		Duration of Max. Peak Current Flow	Type of Test	
		Open	Closed		Close Device On Fault	Close Fault On Device
Heavy Duty 600 Volts a.c. Type TH	210,000	610	497	18°	X	
	210,000	610	497	36°		X
Heavy Duty Interrupter 250 Volts a.c. Type THD	203,000	256	222	18°	X	
	203,000	256	222	18°		X
Heavy Duty Interrupter 600 Volts a.c. Type THD	210,000	610	497	18°	X	
	210,000	610	497	36°		X

GENERAL ELECTRIC

Circuit Protective Devices Dept., Plainville, Conn.

How Reynolds Aluminum Conduit helps

CUT CONTRACTING COSTS

Here's a cost-saving aluminum conduit story told in pictures. It's an actual on-the-job report from Continental Electric Company, San Francisco. Captions are by Mr. Robert D. Hardy of Continental Electric.

"New construction needs new materials," states Mr. Hardy. "We have found aluminum conduit in lift slab construction gave benefits never before anticipated with galvanized rigid conduit . . . we highly recommend the use of aluminum conduit."

Building:
Belcher Apartments,
1800 Pacific Avenue at
Franklin Street,
San Francisco, California

General Contractor:
George Belcher

Electrical Contractor:
Continental Electric Company

Architect:
H. C. Bauman

Engineer:
August E. Waegemann

"Lift-Slab" by Vagtborg Lift-Slab Corporation

AVAILABILITY

Conduit Size Inches	NOMINAL DIMENSIONS (1)—Inches				Threads (3) per Inch	Minimum weight per 100 ft. including one coupling
	Outside Diameter	Inside Diameter	Wall Thickness	Length (2)		
½	.840	.622	.109	9′-11¼″	14	27.4
¾	1.050	.824	.113	9′-11¼″	14	36.4
1	1.315	1.049	.133	9′-11″	11½	53.0
1¼	1.660	1.380	.140	9′-11″	11½	69.6
1½	1.900	1.610	.145	9′-11″	11½	86.2
2	2.375	2.067	.154	9′-11″	11½	115.7
2½	2.875	2.469	.203	9′-10½″	8	182.5
3	3.500	3.068	.216	9′-10½″	8	238.9
3½	4.000	3.548	.226	9′-10¼″	8	287.7
4	4.500	4.026	.237	9′-10¼″	8	340.0
5	5.563	5.047	.258	9′-10″	8	465.4
6	6.625	6.065	.280	9′-10″	8	612.9

1. Dimensions & weights are nominal unless otherwise noted.
2. Lengths of conduit with coupling attached will be nominally 10 ft.
3. American standard tapered pipe threads. Conduit couplings are tapped with straight threads.

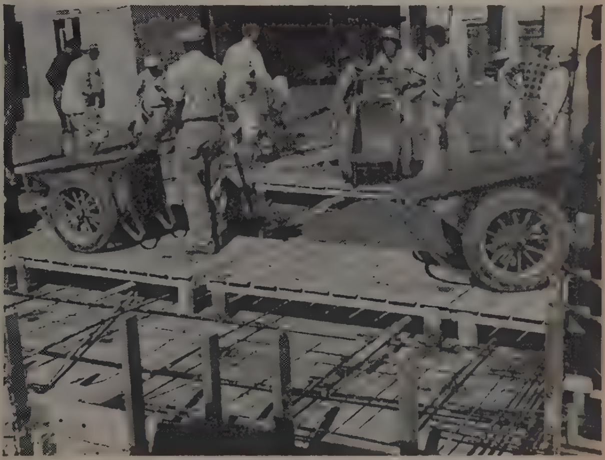
All Reynolds conduit bears the Underwriters' Laboratories Seal of Approval. All rigid conduit is Alloy 6063-T42.

IN PRE-CAST CONSTRUCTION

1. "We threaded all sizes, including ½" and ¾" aluminum conduit, and found that even on smaller sizes, labor time decreased. Due to lightness of aluminum conduit, one-third the man hours were used for moving the large stacks of conduit."

2. "Conduit benders were placed on the conduit that was installed in place to shift the conduit from pre-stressed wires. In many cases, conduit was moved three to four inches by employing hand tools."

3. "Pulling wire through the aluminum conduit did not prove to be any more difficult than installing wire in galvanized conduit."



4. " . . . we found that after the pouring of the slab, we had no damaged conduit and that continuous pounding and battering had still left our risers in proper position and condition."

For complete information and names of Reynolds Aluminum Rigid Conduit distributors, call your Reynolds Sales Office or write *Reynolds Metals Company, P.O. Box 2346-ET, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

Watch Reynolds TV Shows: "Bourbon Street Beat" and "Adventures in Paradise"; and, resuming in October, "All Star Golf"—ABC-TV

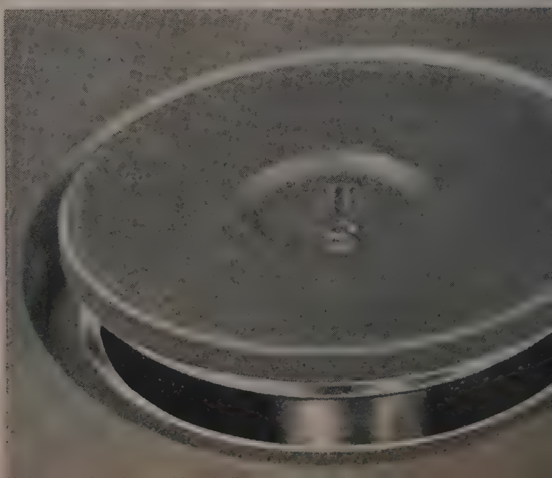
Before it is shipped ever

run-in and teste

Part of Onan's testing facilities—largest electric generating plant testing area in the industry!

Big, brawny bearings on Onan engines—twice the bearing area of most competitive bearings. Means longer life between overhauls. Another of many ways that Onan is built *up* to performance, not built down to a price.

Stellite coated exhaust valves and valve seats. O
of toughest alloys known. Gives you up to 30
longer valve life than uncoated valves. It's the
portant details like this that make Onan more econ
ical in the long run.



nan Electric Plant is
or hours

And we mean *__every__* *Onan Electric Plant! This rugged workout under load means* *__every__* *Onan is ready for hard work the day you get it!*

very Onan plant has a nameplate with rsepower and output ratings. Every ngle plant is put through a series of ugh tests to make sure it does what the meplate says it will do *before it is crated r shipping.*

ut this isn't enough. Inspectors from an dependent laboratory pay our factory equent surprise visits. Their job is to eck and double-check—our tested plants as well as our testing equipment and methods. They pull a plant off the line, run it, stop it, gun it, stall it, check and recheck. The end result is Onan's exclusive *Performance Certification* . . . your guarantee of getting the power you paid for.

See the dependable Onan Generating Power Plants soon. You can find an Onan distributor in the Yellow Pages in every major city, or write direct.

NLY ONAN GIVES YOU THIS CERTIFICATION

PERFORMANCE CERTIFIED

We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.

D. W. ONAN & SONS INC.
Minneapolis 14, Minnesota

Onan

World's
Leading Builder
of Electric
Power Plants

. ONAN & SONS INC., 2636 UNIVERSITY AVE. S.E., MINNEAPOLIS 14, MINN.

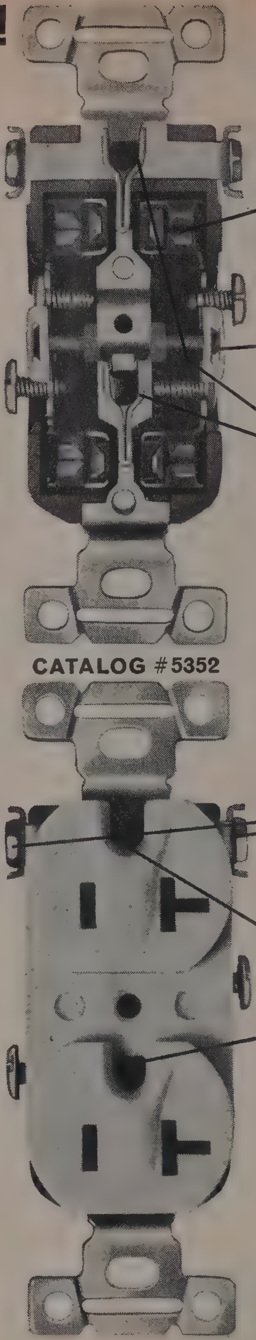
NEW FROM BRYANT! THE ONLY 20-AMP GROUNDING RECEPTACLE WITH TWIST-PROOF GROUNDING CLIP

Bryant receptacles and caps meet the new code requirements with lasting, positive grounding

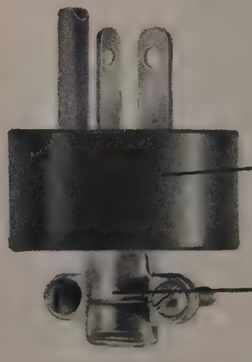
Now you can install 20-amp, 125 volt grounding devices with grounding contacts that cannot be twisted out of shape. Notice the spring wire grounding-clip in the new Bryant receptacle. This spring wire clip always maintains contact tension. With Bryant's new twist-proof clip, you can always be sure of permanent, positive contact.

The new Bryant receptacles and caps meet all the latest NEC requirements for the grounding of certain appliances, office machines and other heavy-duty equipment. This line of 2 pole, 3 wire devices meets all NEMA and ASA specifications and is UL approved.

Your customers, too, will approve the additional features noted on the right. For details contact your Bryant distributor or write to Bryant directly.


DOUBLE-SIDED CONTACTS
SIDE-WIRING WITH BREAK-OFF FEATURE
TWIST-PROOF GROUNDING CLIP
2 GROUNDING TERMINALS
OPEN-END GROUND ENTRANCES ELIMINATE LIP BREAKAGE

CATALOG #5352



CATALOG #5374

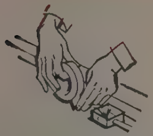
BRYANT

THE BRYANT ELECTRIC COMPANY
BRIDGEPORT 2, CONNECTICUT

J-99044

Every 42.8 seconds a sparkling new Lark rolls off these Studebaker-Packard assembly lines.

How J-M Dutch Brand Plastic Electrical Tape Helped Studebaker-Packard Cut Electrical Down-Time 91.75%



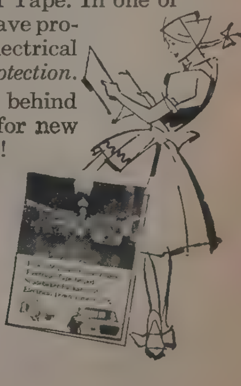
***Another critical wiring connection along Studebaker-Packard assembly lines gets quick, complete protection with Dutch Brand Plastic Electrical Tape.**

Wiring connections everywhere at Studebaker-Packard's South Bend plant needed durable protection from multiple enemies. Production of the brilliant new Studebaker Lark was booming, and just one serious electrical failure could affect the whole six-mile assembly line.

Durable, broad protection was found in Dutch Brand Plastic Electrical Tape. In one or two thicknesses, it gave high dielectric strength and exceptional resistance to the many enemies of wiring connections—among them, grease, oil, moisture, abrasion, acids.

Savings? Hundreds of manhour dollars per *day*! Instead of 12 minutes electrical down-time daily—or a production loss of about 16 Studebaker Larks—the average fell to one minute. Given as a reason for this savings was the switch to J-M Dutch Brand Plastic Electrical Tape. In one or two snug, economical turns, it gave protection which could slash electrical down-time—*broad, durable protection.*

See the full, fascinating story behind this enormous savings. Write for new "Studebaker-Packard" booklet!



JOHNS-MANVILLE DUTCH BRAND DIVISION
7800 South Woodlawn Avenue, Chicago 19, Illinois
In Canada—Johns-Manville Co., Ltd., Port Credit, Ontario

JOHNS-MANVILLE
JM
PRODUCTS

JOHNS-MANVILLE

How Day-Brite lighting helps a school prepare for tomorrow

The "little red school house" was fine in its day, but future demands on our educational system require a new kind of educational plant. This high school, incorporating some of today's most forward-looking architectural concepts, promises to remain modern and efficient for years to come.

With great attention given to both form and function throughout, Day-Brite was the logical lighting choice. Semester after semester after semester, these fixtures will provide highest visual comfort with substantial long-range operating and maintenance economies.

If a school building or remodeling project figures in your "tomorrow", consult your Day-Brite representative about the lighting designed with "tomorrow" in mind. *Day-Brite Lighting, Inc., 6260 N. Broadway, St. Louis 15, Mo. and Santa Clara, Calif. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ont.*

DAY-BRITE

NATION'S LARGEST MANUFACTURER OF
COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

perb Day-Brite Holiday fixtures maintain a minimum lighting level of 70 footcandles.

inceton High School,
tside of Cincinnati

chitect:
tter, Tyler, Martin and Rot.

nsulting Engineer:
sdick and Hilmer

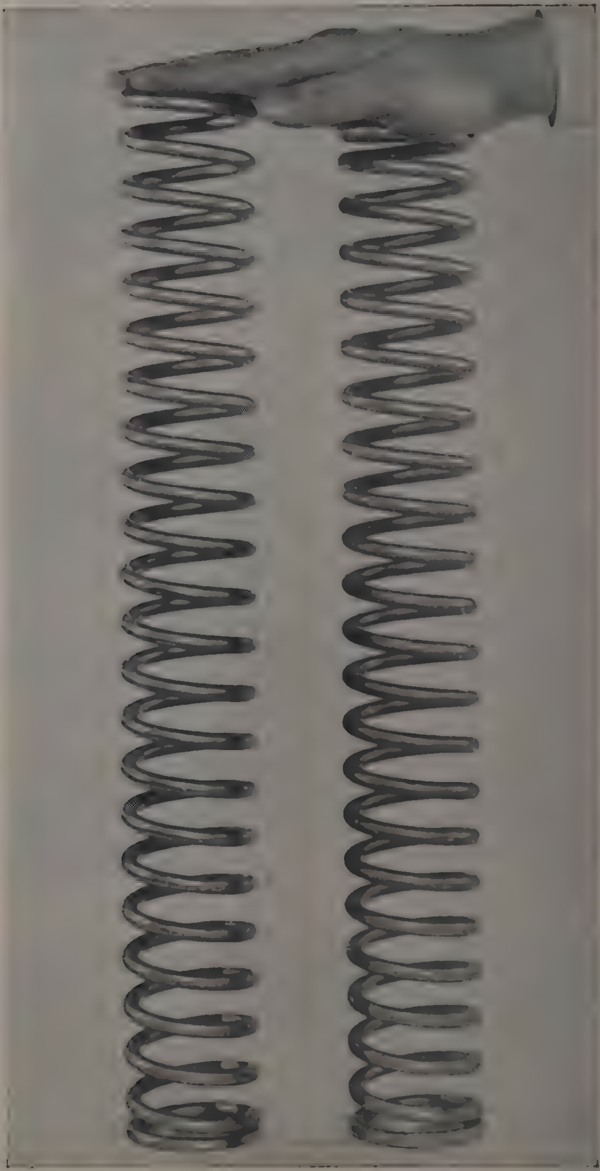
ectrical Contractor:
ltzhoover Electric Co.

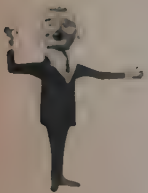
Molded acrylic plastic enclosures control light prismatically, eliminating glare.

What New Metal-

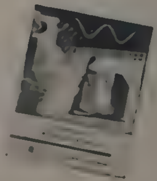
Has closed-door drawout . . .

Stored energy as standard . . .





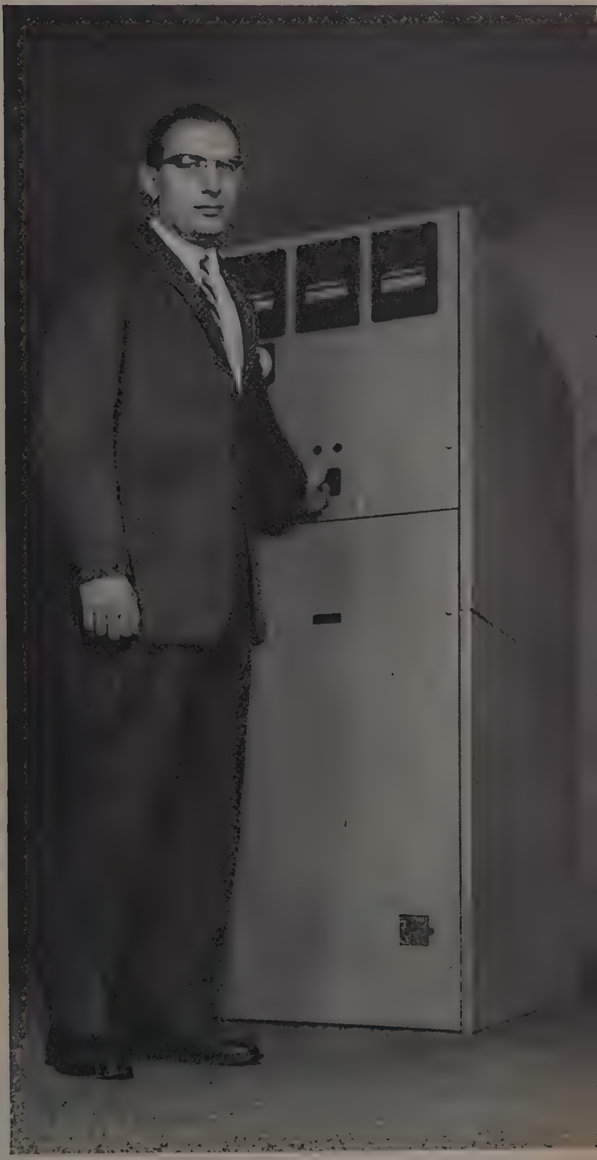
For complete answer, send for new illustrated Bulletin 2801-2A. And ask to see sound strip film that shows you every detail in only 18 minutes. Can be shown to you singly or to your group. Contact your nearby I-T-E sales office. Or write I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Phila. 30, Pa.



Clad Switchgear...

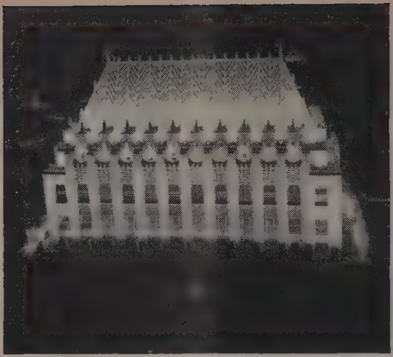
More elbow room inside...

Yet fits in tighter spaces?



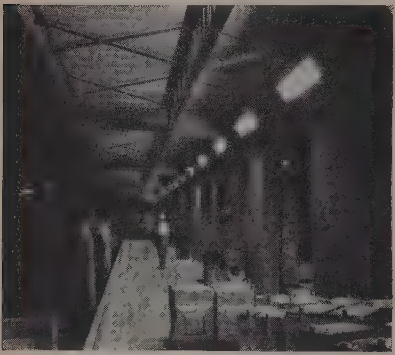
I-T-E CIRCUIT BREAKER COMPANY

PERIMETER LIGHTING helps prevent trespassing and costly pilfering.



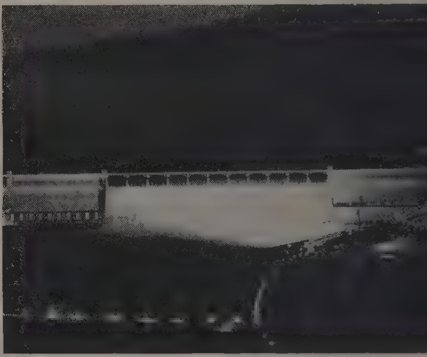
ARCHITECTURAL LIGHTING will add prestige and beauty to buildings.

SHOPPING CENTERS boost nighttime business when brightly lighted.

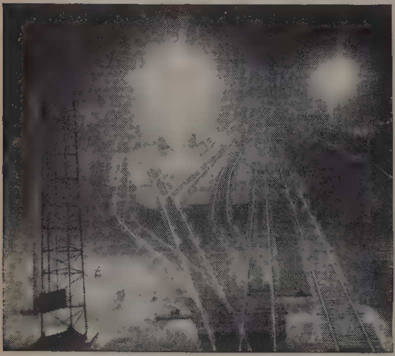


LOADING DOCKS become safer, more efficient when properly lighted.

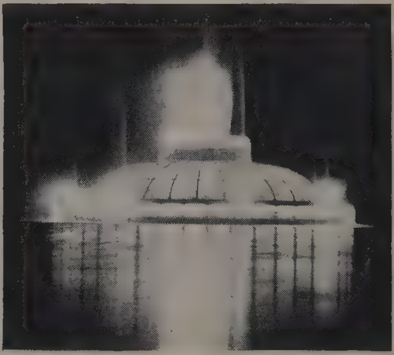
FACADE LIGHTING gives safety, identification to building and store fronts.



GRAND COULEE DAM lighted by 742 General Electric 1500-watt floodlights.

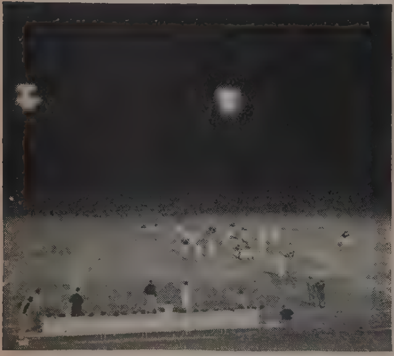


RAILROAD YARD lighting cuts accidents, thefts and costly freight damage.



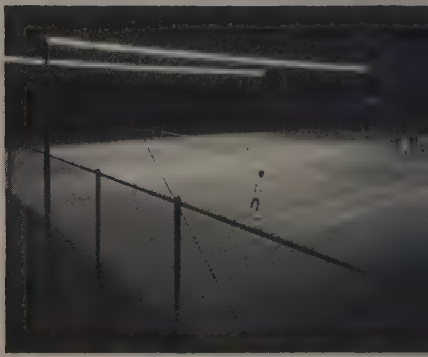
FOUNTAINS assume day-time beauty with brilliant, multi-colored floodlights.

NIGHT CONSTRUCTION is safer and more practical with floodlighting.



ATHLETIC FIELD lighting lengthens the time available for fun and play.

DOCK FACILITIES nighttime usage is greatly increased with floodlights.

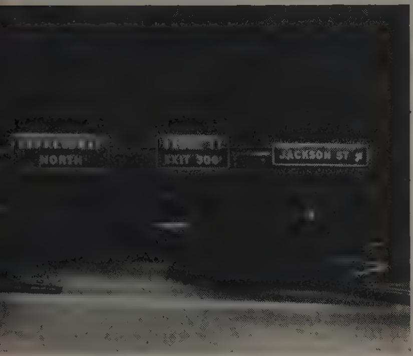


TENNIS COURTS attain round-the-clock use with modern floodlighting.

When light means more safety, fun, beauty, or efficiency, General Electric floodlights will do it best—at least cost

STORAGE YARDS can be just as accessible at night as they are by day.

PLANT ENTRANCES need modern lighting to facilitate visitor checking.



GUIDE SIGN lighting adds convenience, safety to highway travel.

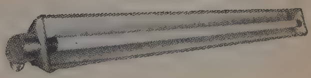
AIRPORTS become safer, and more convenient with proper floodlighting.

As floodlights in these 16 areas are switched on there is an immediate addition of beauty, safety, efficiency. Nighttime crowds fill the lighted recreational areas; movement of raw materials and finished goods is speeded on lighted loading docks; a fountain with multi-colored lights becomes a nighttime landmark.

These are typical results of proper outdoor lighting. The benefits are many—the applications unlimited. But, regardless of the job to be done—from Grand Coulee Dam to highway guide signs, from Milwaukee's County Stadium to railroad yards—General Electric has experience to do the job best . . . and a full line of floodlights to do it at least cost:

FILAMENT OR MERCURY LIGHTING is simple with any of General Electric's L-69A (high efficiency), L-80 (heavy-duty enclosed), or L-55 (economy open-type) units. Each of these floodlights features G.E.'s exclusive "diamond back" reflector . . . designed to deliver from 5% to 35% more light . . . and distribute it more uniformly.

FLUORESCENT LIGHTING units are available in 4-, 6-, and 8-foot lengths. Two housings are offered—one for G.E.'s High Output lamps—the other for G.E.'s Power Groove lamps.



Here's an added benefit—over 500 conveniently located distributors are ready to supply General Electric floodlights and technical aid for your installation. Call your nearest distributor—ask for General Electric's *new* Floodlighting bulletin with descriptions, application information, and product data on the complete line. G-E Easy Lighting Layouts are also available for most floodlighting applications. Use the coupon below if you don't know the distributor in your area.

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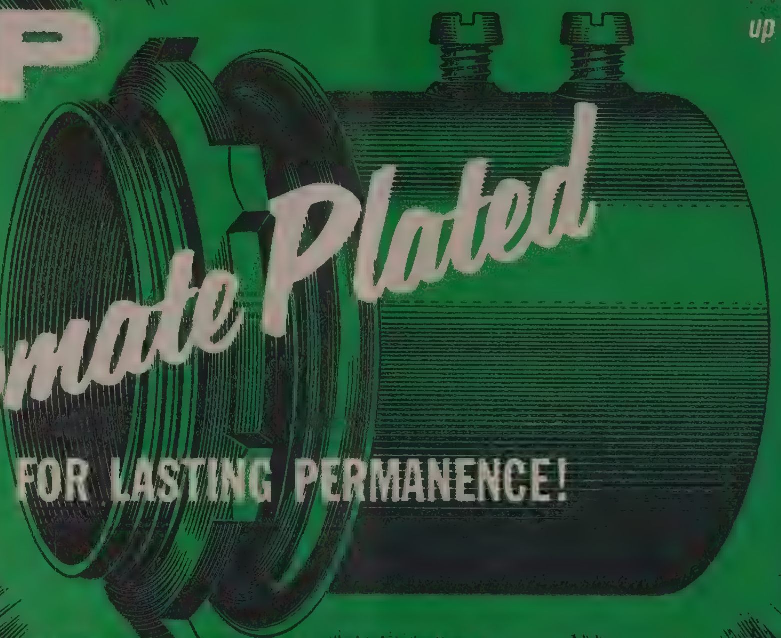

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- One piece solid tubular steel—cannot open or spread. Sized for uniformity.
- Available in ½", ¾", 1", 1¼" (one screw type) and 1½" and 2" (two screw type) sizes.
- Concrete tight with heaviest gauge wall thickness! Far surpasses U.L. requirements. U.L. file card E24788.

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ELECTRICAL
CONSTRUCTION
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Competitive Approach

Live Better Electrically promotion will adopt a powerful new approach in 1961. The huge consumer program under the direction of the Edison Electric Institute will be concentrating heavily on the most critical major appliances which involve a decisive choice between electricity and flame by the consumer. It will become openly and aggressively competitive with other fuels and services.

"Flameless" is a vitally important key word in the new campaign. As an exclusive benefit available only in electrical equipment, it will be used prominently with the theme, "you live better electrically." It is, of course, a head-on challenge to the well-known symbol of the gas industry, the blue flame. And the new policy objective of LBE, "to sell more kilowatt hours by featuring specific competitive equipment with the total electric living concept," is testimony to the current evolution in utility attitudes toward heating loads.

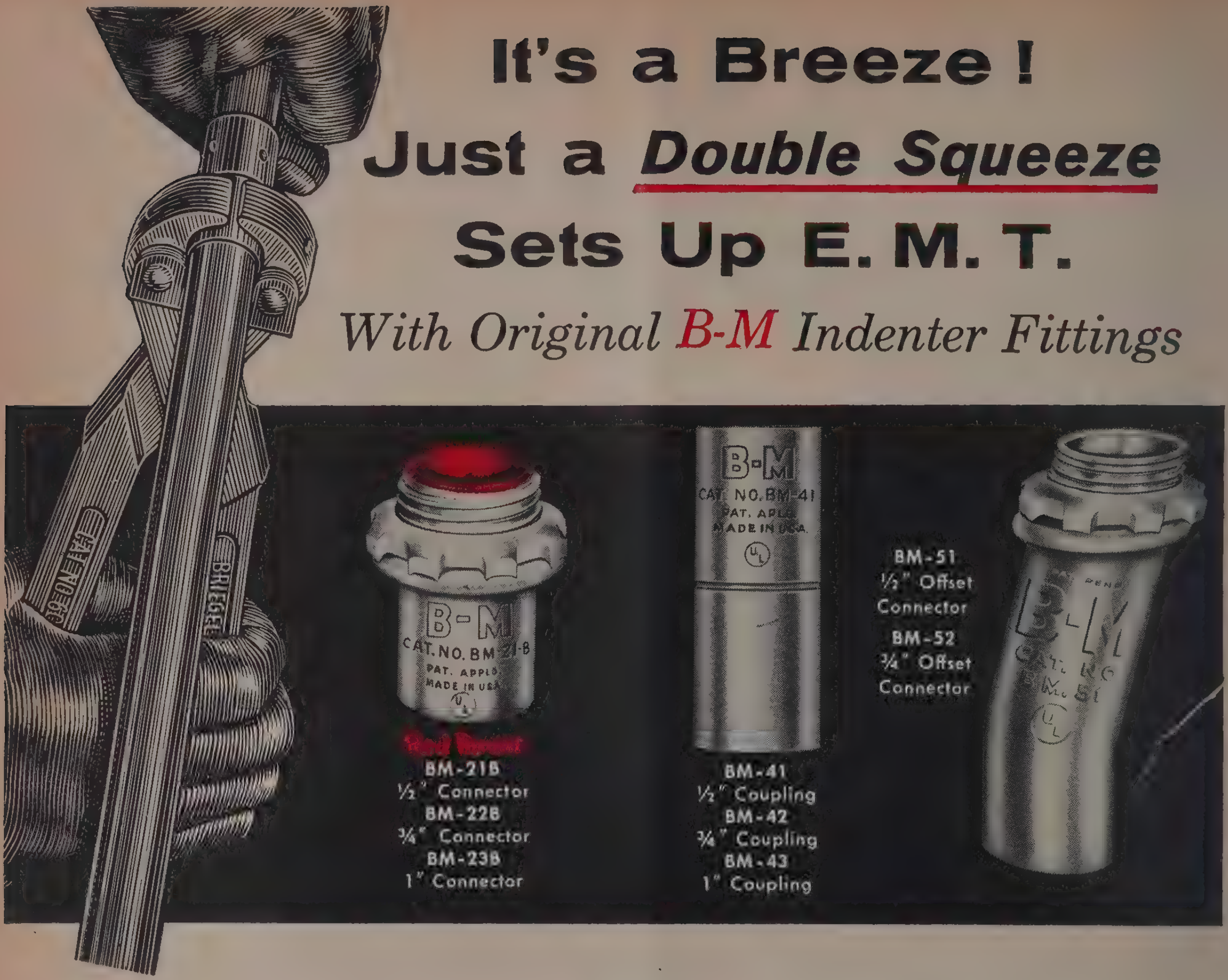
Concentration on key utilization equipment; heating, cooling, water heating, cooking and drying; is also significant. These are the competitive areas where a customer's decision on one or two can effectively influence the entire list. These are also the areas where the exclusive flameless benefits of electrical equipment can be exploited to the best advantage.

The key role of the electrical contractor in relation to the new competitive LBE promotion is more important than ever before. He must, consequently, thoroughly understand the total electric living concept. He must recognize that any compromise short of full housepower will inevitably throw roadblocks in the way of installing one or more critical competitive equipments. And any deficiency will be exploited quickly by other services.

The all-electric home involves electrical work running three or more times the value of the conventional wiring of a home with mixed services. For the electrical contractor also equipped to sell and install major appliances, the stakes are even higher. LBE and parallel industry promotion and advertising will be creating forcefully a broadly expanded market for the goods and services of the electrical contractor. It is clearly in his vital self-interest to be an aggressive, well-informed and cooperative member of the industry team devoted to bringing the maximum benefits of electric living to the public.

Wm. T. Stuart

It's a Breeze!
Just a *Double Squeeze*
Sets Up E. M. T.
With Original B-M Indenter Fittings

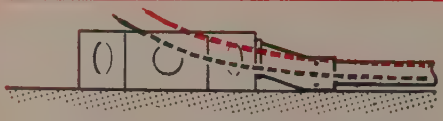


[illegible]
BM-21B
½" Connector
BM-22B
¾" Connector
BM-23B
1" Connector

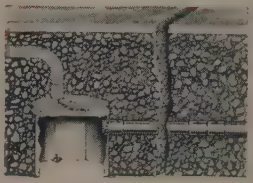
BM-41
½" Coupling
BM-42
¾" Coupling
BM-43
1" Coupling

BM-51
½" Offset
Connector
BM-52
¾" Offset
Connector

● B-M Indenter Fittings and Tools make an unbeatable combination when it comes to easier E.M.T. installation at less cost. New lightweight plier size indenters make setting up thin wall conduit a breeze. B-M fittings are neater too! No unsightly nuts or projecting set screws. Other plus features of B-M fittings are Concrete tight—Vibration resistant—Extra heavy bright zinc plate, salt spray and acid drip tested for corrosion resistance—Extra heavy positive bonding locknuts—Smooth rounded edges or bushed throat type connectors that prevent insulation damage—All steel construction with extra heavy gauge wall thickness.


B-M Offset Connector, showing how wires are guided over box edge.

Briegel All Steel Indenter Fittings are U.L. approved as Concrete-Tight.



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All B-M indenter type fittings far exceed the requirements of U. L. file card E 10863 and Federal Specifications W-F-406.

TELESCOPE BM SYSTEM

USED THE MOST FROM COAST TO COAST

ELECTRICAL
CONSTRUCTION
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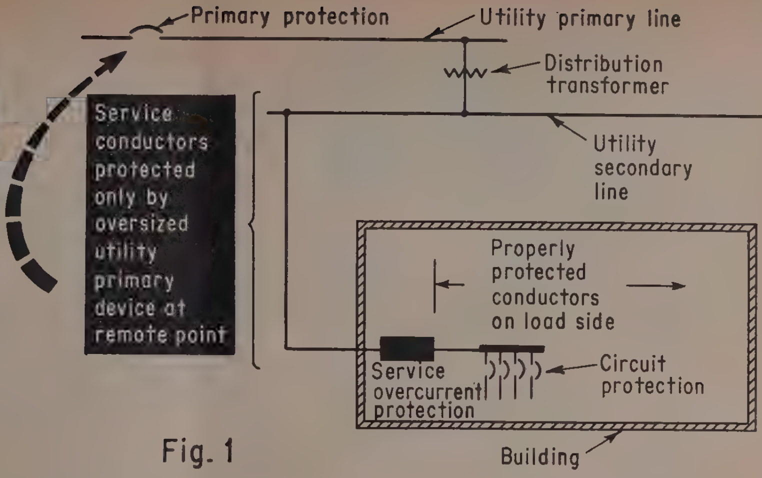

Primary protection
Utility primary line
Distribution transformer
Utility secondary line
Service conductors protected only by oversized utility primary device at remote point
Properly protected conductors on load side
Service overcurrent protection
Circuit protection
Building

Fig. 1

Analysis of code rules on . . .

Grounding—Bonding of Services

Effective grounding and bonding of service-entrance equipment is a prime consideration in modern electrical systems. Here's a rundown on pertinent rules of the National Electrical Code and the methods and devices commonly used to satisfy basic requirements.

By J. F. McPartland

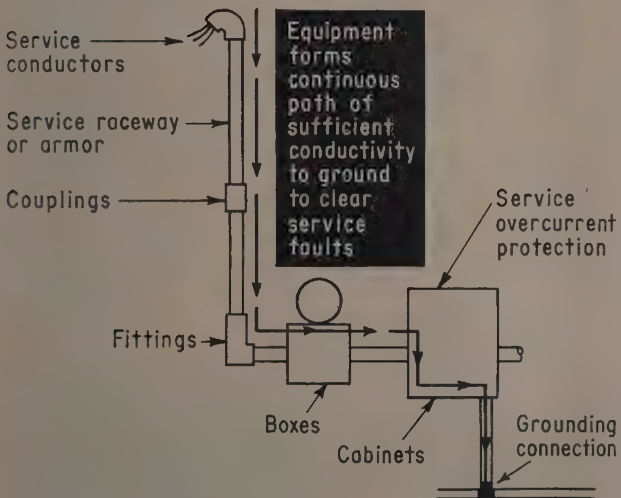

Service conductors
Service raceway or armor
Couplings
Equipment forms continuous path of sufficient conductivity to ground to clear service faults
Service overcurrent protection
Fittings
Boxes
Cabinets
Grounding connection

Fig. 2

ONE of the most interesting and controversial phases of electrical work involves the grounding and bonding of secondary-voltage service-entrance equipment. Modern practice in such work varies according to local interpretations of code requirements and specifications of design engineers. In all cases, however, the basic intent is to provide an installation which is essentially free from hazard to life and property. The following is a resume of National Electrical Code rules on the subject with practical methods for achieving objectives.

The need for effective grounding and bonding of service equipment arises from the electrical characteristics of utility-supply circuits. In the common arrangement, service conductors are run to a building, and the service overcurrent protection is placed near the point of entry of the conductors into the building, at the load end of the conductors. With such a layout, the service conductors are not properly protected against ground faults or shorts occurring on the supply side of the service overcurrent protection. Generally, the only protection for the service conductors is on the primary side of the utility's distribution transformer. Fig. 1.

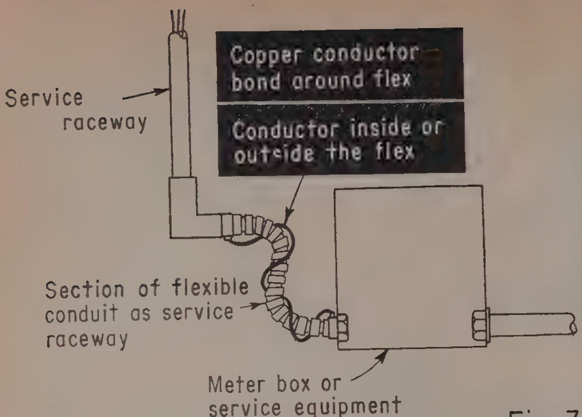

Service raceway
Copper conductor bond around flex
Conductor inside or outside the flex
Section of flexible conduit as service raceway
Meter box or service equipment

Fig. 3

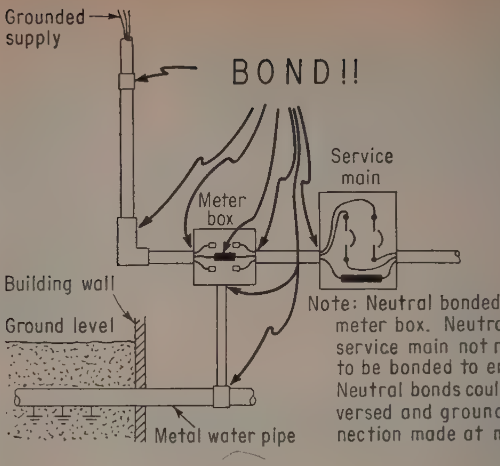


Fig. 4

Note: Neutral bonded to meter box. Neutral bar in service main not required to be bonded to enclosure. Neutral bonds could be reversed and ground connection made at main.

In view of the foregoing, all enclosures for service conductors must be grounded to prevent a potential above ground on the enclosures as a result of fault—which would be a very definite hazard—and to facilitate operation of overcurrent devices anywhere on the supply side of the service conductors. However, because of the distant location of the protection and the normal impedance of supply cables, it is important that any fault to an enclosure of a hot service conductor of a grounded electrical system find a firm, continuous, low-impedance path to ground to assure sufficient current flow to operate the primary protective device or to quickly burn the fault clear. Fig. 2. This means that all enclosures containing the service conductors—service raceway, cable armor, boxes, fittings, cabinets—must be effectively bonded together, that is, they must have low impedance through themselves and must be securely connected to each other to assure a continuous path of sufficient conductivity to the conductor which makes the connection to ground.

The spirit of the code and good engineering practice have long recognized that the conductivity of any equipment ground path should be approximately equivalent to 25% of the conductivity of any phase conductor with which the ground path will act as a circuit conductor on a ground fault. Or, to put it another way, making the relationship without reference to insulation or temperature rise, the impedance of the ground path must not be greater than four times the impedance of any phase conductor with which it is associated. This figure should always be used as a specific guide when evaluating the suitability of raceways or conductors as a grounding path.

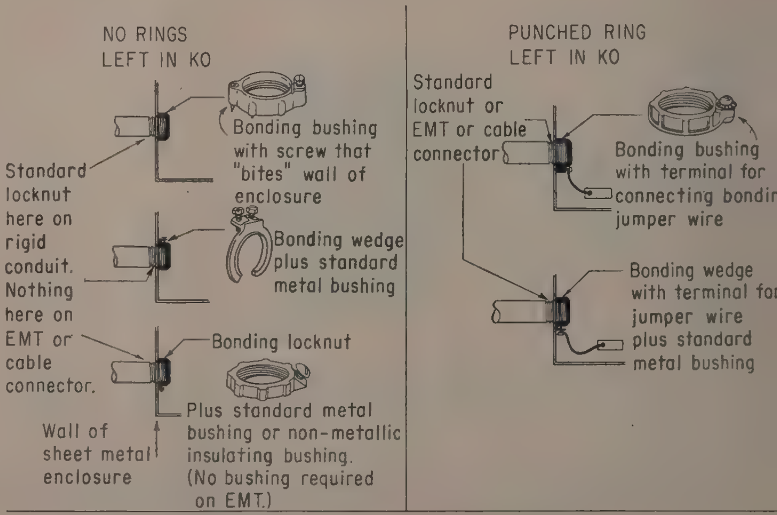
In ungrounded electrical systems, the same careful attention should be paid to the matter of bonding together the non-current-carrying metal parts of all enclosures containing service conductors. Such a low-impedance ground path will quickly and surely ground any hot conductor which might accidentally become common with the enclosure system.

Specific NE Code requirements on grounding and bonding are as follows:

1. Section 230-63 requires that service raceways, metal sheath of service cables, metering enclosures and cabinets for service disconnect and protection be grounded. An exception to this rule is made in the case of certain lead-sheathed cable services. A further requirement is that flexible metal conduit used in a run of service raceway must be bonded around. Fig. 3. That is, a copper conductor of the same size as the grounding conductor required for the size of service must be used to jumper the length o flex.

2. Section 250-32 also requires that service raceways, service cable sheaths or armoring—when o metal—be grounded.

3. Section 250-71 sets forth th service equipment which must b bonded—that is the equipment fo which the continuity of the grounding path must be specifically assured. Fig. 4. This equipment includes: (a) service raceway, cabl sheath and cable armor; (b) al service equipment enclosures containing service-entrance conductors including meter fittings, boxes, etc.


NO RINGS LEFT IN KO
Bonding bushing with screw that "bites" wall of enclosure
Standard locknut here on rigid conduit. Nothing here on EMT or cable connector.
Bonding wedge plus standard metal bushing
Bonding locknut
Plus standard metal bushing or non-metallic insulating bushing. (No bushing required on EMT.)
Wall of sheet metal enclosure
PUNCHED RING LEFT IN KO
Standard locknut or EMT or cable connector
Bonding bushing with terminal for connecting bondir jumper wire
Bonding wedge with terminal fo jumper wire plus standard metal bushing

METHODS OF BONDING RACEWAY TO SHEET METAL ENCLOSURE

Fig. 5

interposed in the service raceway or armor; and (c) any conduit or armor which forms part of the grounding conductor to the service raceway.

4. Section 250-72 sets forth the specific means which must be used to connect service conductor enclosures together to satisfy the bonding requirements of 250-71. These means include:

a. Bonding equipment to the grounded service conductor by means of suitable lugs, pressure connectors, clamps or other approved means—except that soldered connections must not be used. Sec. 250-61 permits grounding of meter housings and service equipment to the grounded service conductor on the supply side of the service disconnecting means.

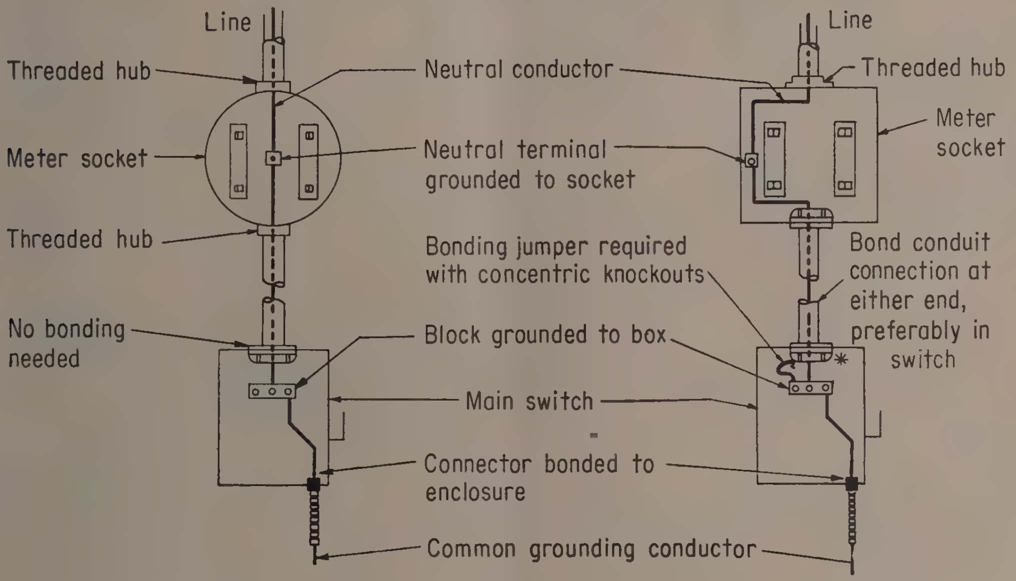
b. Threaded couplings in rigid metal conduit runs and threaded bosses on enclosures to which rigid metal conduit connects.

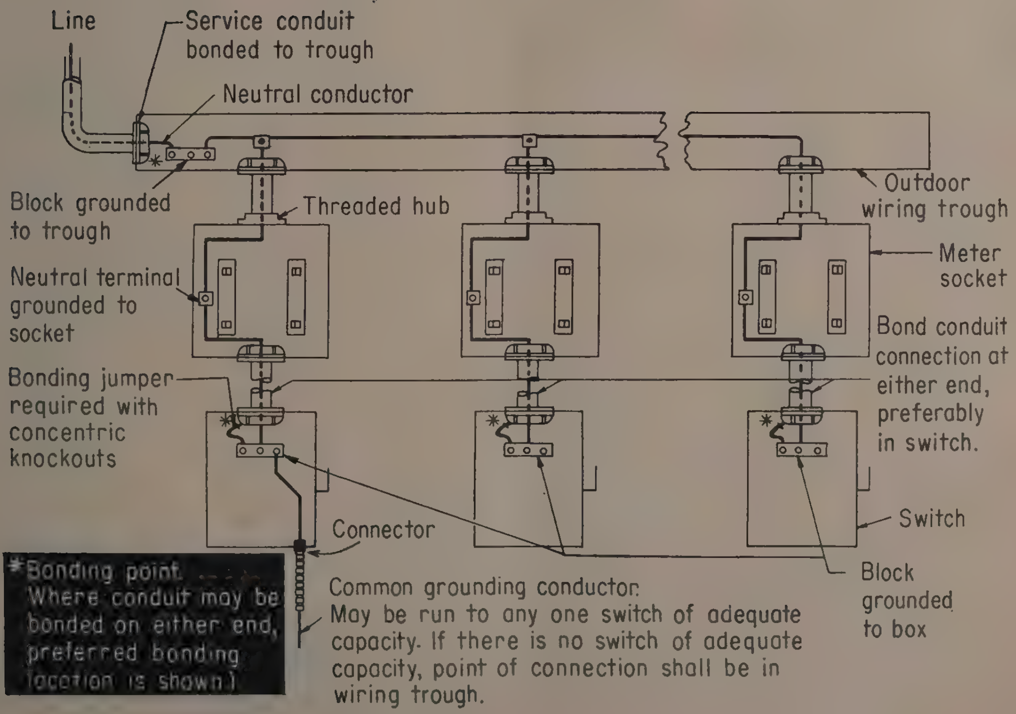
c. Threadless couplings made up tight for rigid metal conduit or electrical metallic tubing.

d. Bonding jumpers to securely connect metallic parts. Bonding jumpers must be used around concentric or eccentric knockouts which are punched or otherwise formed so as to impair the electrical connection to ground.

e. Other devices (not locknuts and bushings) approved for the purpose.

TYPICAL METER SOCKET INSTALLATIONS


Line
Threaded hub
Meter socket
Threaded hub
No bonding needed
Neutral conductor
Neutral terminal grounded to socket
Bonding jumper required with concentric knockouts
Block grounded to box
Main switch
Connector bonded to enclosure
Common grounding conductor
Line
Threaded hub
Meter socket
Bond conduit connection at either end, preferably in switch
*

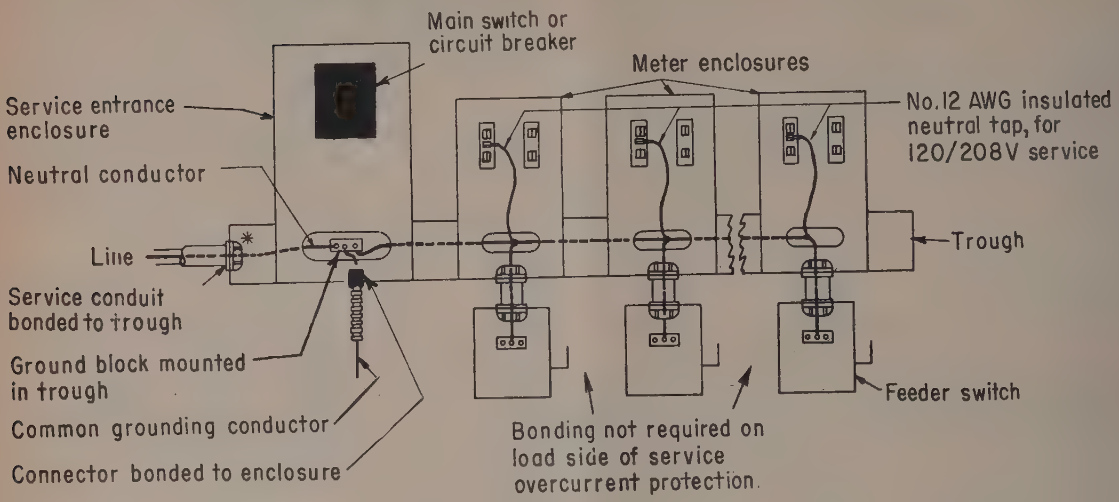

Line
Service conduit bonded to trough
Neutral conductor
Block grounded to trough
Threaded hub
Neutral terminal grounded to socket
Bonding jumper required with concentric knockouts
Outdoor wiring trough
Meter socket
Bond conduit connection at either end, preferably in switch.
Switch
Block grounded to box
Connector
*

Common grounding conductor. May be run to any one switch of adequate capacity. If there is no switch of adequate capacity, point of connection shall be in wiring trough.

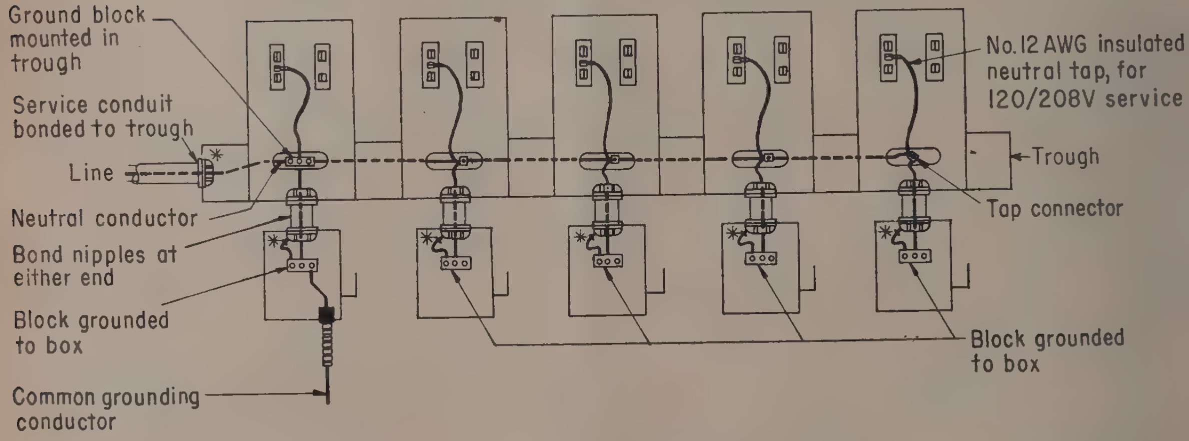
*Bonding point (Where conduit may be bonded on either end, preferred bonding location is shown)

TYPICAL METER ENCLOSURE INSTALLATIONS
(120/208-VOLT OR 120/240-VOLT SERVICES)

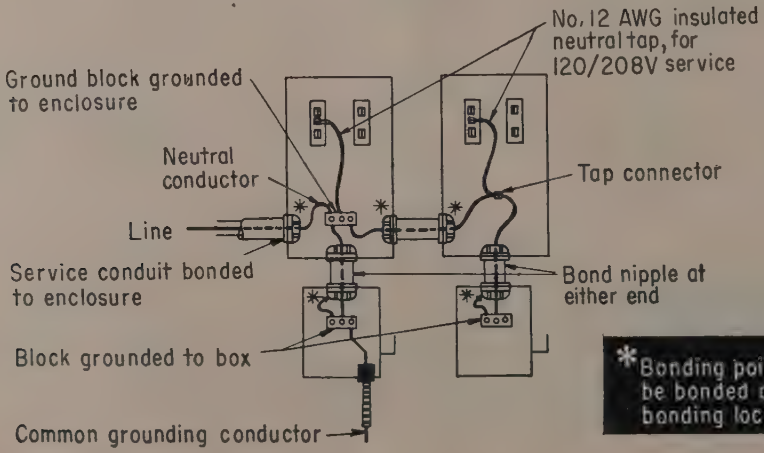
TROUGH INSTALLATION – MORE THAN 6 METERS


Main switch or circuit breaker
Meter enclosures
Service entrance enclosure
No. 12 AWG insulated neutral tap, for 120/208V service
Neutral conductor
Line
Trough
Service conduit bonded to trough
Ground block mounted in trough
Feeder switch
Common grounding conductor
Connector bonded to enclosure
Bonding not required on load side of service overcurrent protection.

TROUGH INSTALLATION – UP TO 6 METERS


Ground block mounted in trough
No. 12 AWG insulated neutral tap, for 120/208V service
Service conduit bonded to trough
Line
Trough
Tap connector
Neutral conductor
Bond nipples at either end
Block grounded to box
Block grounded to box
Common grounding conductor

METER ENCLOSURES NIPPLED TOGETHER


No. 12 AWG insulated neutral tap, for 120/208V service
Ground block grounded to enclosure
Neutral conductor
Tap connector
Line
Service conduit bonded to enclosure
Bond nipple at either end
Block grounded to box
Common grounding conductor

*Bonding point. (Where conduit may be bonded on either end, preferred bonding location is shown.)

Based on these requirements, modern practice follows more or less standard methods:

Where rigid conduit is the service raceway, threaded or threadless couplings are used to couple sections of conduit together. Conduit connection to a meter socket may be made: by connecting a threaded conduit end to a threaded hub or boss on the socket housing, where the housing is so constructed; by a locknut and bonding bushing; by a locknut outside with a bonding wedge or bonding locknut and a standard metal or completely insulating bushing inside; or sometimes by a locknut and standard bushing where the socket enclosure is bonded to the grounded service conductor. Conduit connections to KOs in sheet metal enclosures can be made with a bonding locknut, a bonding wedge or a bonding bushing where no KO rings remain around the opening through which the conduit enters. Where a KO ring does remain around the conduit entry hole, a bonding bushing or wedge with a jumper wire must be used to assure a path of continuity from the conduit to the enclosure. Fig. 5. It should be noted that the use of the common locknut and bushing type of connection is not allowed. Neither is the use of double locknuts—one inside, one outside—and a bushing. The special methods set forth in the code are designed to prevent poor connections or loosening of connections due to vibration. This minimizes the possibility of arcing and consequent damage which might result when a service conductor faults to the grounded equipment.

Similar provisions are used to assure continuity of the ground path when EMT is the service raceway or when armored cable is used. EMT is coupled by threadless devices—compression-type, indenter-type or set-screw type, using raintight couplings outdoors. Standard connectors are used to connect EMT to enclosures. Bonding between the EMT fittings and the enclosures is accomplished in the same way as with rigid conduit. And fittings used with service cable armor must assure the same degree of continuity of ground path.

It should be noted that Section 250-72 makes no specific mention of connectors for rigid conduit or EMT, except for the use of threaded bosses with rigid conduit. The use of bonding bushings, bonding wedges and bonding locknuts is recognized without reference to types of raceways or types of connectors used with the raceways or cable armor. As a result, common sense and experience have molded modern engineering practice in making raceway and armored service cable connection to service cabinets.

A number of other NE Code provisions relate to the matter of suitable connections at service cabinets, as follows:

1. Where rigid conduit enters a box or enclosure, a bushing must be provided to protect the conductors from abrasion.

2. There is no requirement that a bushing be used on an EMT connector.

3. However, where ungrounded conductors of No. 4 or larger enter a raceway (this includes rigid conduit and EMT) in a cabinet, pull box, junction box or auxiliary gutter, the conductors shall be protected by a substantial bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by insulating material securely fastened in place. Where a conduit bushing is constructed wholly of insulating material, a locknut must be used both inside and outside the enclosure to which the conduit is connected.

An important and highly controversial technique in the bonding system involves the method of connecting from the service equipment to the water pipe or other electrode with the grounding conductor. There are a number of elements in such connection:

1. The grounding conductor in the case of a grounded electrical system may be a solid or stranded, insulated or bare conductor of copper or other corrosion-resistant material. Such a conductor is used to ground both the grounded circuit conductor and the system equipment, housings, raceways and other non-current carrying metal parts—including service equipment and raceways. This grounding conductor may be connected to the grounded circuit conductor (such as the neutral) at any convenient point on the supply side of the service disconnect. Connection of the grounding conductor to the interconnected layout of service equipment and other equipment is usually made at the same point. The most common example is that of the neutral bus which is bonded to the enclosure of the service equipment. Although the use of a common grounding conductor for both wiring and equipment in a grounded system appears to be optional from Sec. 250-53, a reading of 250-94 (b) makes clear that a separate grounding conductor for equipment only may be used only "where the wiring system is not grounded at the premises."

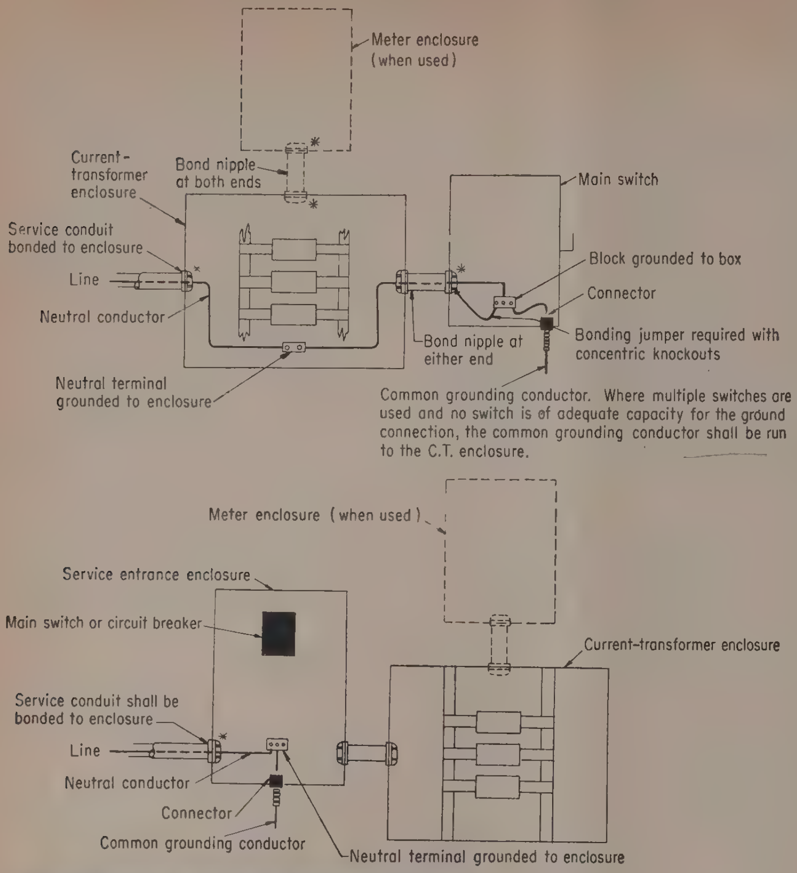
2. A grounding conductor for service raceway and equipment in an ungrounded electrical system may be: a solid or stranded, insulated or bare conductor of copper or other corrosion-resistant material; rigid metal conduit; EMT; or a bus bar. Sec. 250-94 (b) gives the sizes of such grounding conductors. It should be noted, though, that where corrosive atmospheres prevail, the grounding conductor for equipment only must be made of copper or other corrosion-resistant material.

3. A service grounding conductor used to ground both the grounded conductor and the equipment or used to ground equipment only may be installed directly on the surface on which it is run—without insulators or protection—when it is No. 4 or larger and not exposed to "severe" physical damage. No. 6 grounding conductors which are not exposed to physical damage may be run on the surface of building construction without protection if rigidly stapled to the construction. Otherwise, it must be in conduit, EMT or armor. Grounding conductors smaller than No. 6 must be protected by conduit, EMT or armor.

4. Where rigid metal conduit, EMT or armor is used to protect a grounding conductor, it must be electrically continuous from the point of connection to cabinets or equipment to the grounding electrode and must be securely fastened to the ground clamp or fitting.

A question which always arises with respect to the conduit or armor in which a grounding conductor is run to a water pipe or electrode is whether or not the conduit or armor must be bonded to the cabinet at point of attachment and bonded throughout its length. Many engineers and inspection authorities require such bonding. An argument in favor of such bonding can be made by interpreting and correlating certain code requirements:

TYPICAL CURRENT–TRANSFORMER INSTALLATIONS


Meter enclosure (when used)
Current-transformer enclosure
Bond nipple at both ends
Main switch
Service conduit bonded to enclosure
Line
Block grounded to box
Connector
Neutral conductor
Bond nipple at either end
Bonding jumper required with concentric knockouts
Neutral terminal grounded to enclosure
Common grounding conductor. Where multiple switches are used and no switch is of adequate capacity for the ground connection, the common grounding conductor shall be run to the C.T. enclosure.
Meter enclosure (when used)
Service entrance enclosure
Main switch or circuit breaker
Current-transformer enclosure
Service conduit shall be bonded to enclosure
Line
Neutral conductor
Connector
Common grounding conductor
Neutral terminal grounded to enclosure

* Bonding point. (Where conduit may be bonded on either end, preferred bonding location is shown.)

The code says (Sec. 250-71 c) that any conduit or armor which forms part of the grounding conductor to the service raceway must have its continuity assured in the same general manner as continuity is assured for the service raceway. Combining this with the requirement that metallic enclosures for grounding conductors must be electrically continuous and must be connected to the grounding fitting, many designers and constructors have concluded that any metallic raceway or armor for grounding conductor must be bonded to the cabinet or service enclosure from which the grounding conductor enters the raceway or armor. Further, it has been concluded that the length of run of such raceway or armor must also be bonded. This is all based on the fact that a raceway or armor is by its very use a ground path in parallel with the grounding conductor, fulfilling the code condition for required bonding—"conduit or armor which forms part of the grounding conductor to the service raceway."

Assuring the continuity of raceway or armor for a grounding conductor does reduce the impedance of the ground path compared with what the impedance would be if the raceway or armor had poor connections or even opens. Effective bonding of the raceway or armor minimizes the dc resistance of the ground path and reduces the overall impedance which includes the choke action due to presence of magnetic material (steel conduit or armor), the increased inductive reactance of the circuit.

A technical disagreement with the above contention for bonding grounding raceway is made, in effect, in an official interpretation of the National Electrical Code. Official Interpretation No. 350, issued in 1950, made the following rulings:

"SECTIONS 2598, 2571c, 2592—(now Secs. 250-98, 250-71c, 250-92).

"STATEMENT: A rigid conduit enclosing branch circuit conductors runs from the service equipment to a point near the grounding electrode.

"QUESTION NO. 1: Is it the intent of Section 2598 of the 1947 National Electrical Code to permit the service grounding conductor to run through rigid conduit and one or more outlet boxes, enclosing branch circuit conductors to a point near the system grounding electrode, when such a service is supplied by an overhead distribution system?

"ANSWER: YES

"QUESTION NO. 2: Is it the intent of Section 2571c that all rigid conduit raceways enclosing the system grounding conductor be bonded?

"ANSWER: No; this paragraph applies when the conduit itself is the grounding conductor as permitted in Section 2592."

This interpretation indicates that bonding is not required at connections or couplings in raceway or armor protecting a grounding conductor—such as might be used with grounded or ungrounded systems. However, where only the raceway is used as the grounding conductor—which is permitted for equipment grounding in ungrounded systems—the continuity of the ground path must be assured by bonding connections and couplings in the raceway run.

It is difficult to understand how the above interpretation applies to cable armor as set forth in Sec. 250-71 c. It is not likely that cable armor itself would ever be the grounding conductor, without using the enclosed conductor. When, then, would armor be bonded?

The basic conflict between the official interpretation and the common interpretation that bonding is required in ground conductor enclosures must be resolved in accordance with engineering judgment and local rules. Of course, the code viewpoint represents only a minimum safety standard. Engineering analysis can and does often dictate an order of safety above the code level. For these reasons, bonding of grounding conduit is widely accepted as essential to fulfilling the code intent.

Accompanying diagrams of typical installation practice illustrate the fundamentals of grounding and bonding at services.

Calculating Heat-Loss Factors

How to determine U-factors for building walls, floors, and ceilings.

By W. J. Novak

TABLES of heat-loss factors for common constructions are made available to the designer of electric heating installations by equipment manufacturers, insulation manufacturers, and technical publications. However, unusual combinations of materials are frequently encountered for the first time which are not included in such tables, and a guess must be resorted to unless the designer can start from scratch and work out his own U-factors.

The process is a simple one. It may be more completely understood by first comparing the flow of heat with the flow of electricity.

Electrical Analogy

In the electrical circuit of Fig. 1, voltage V_1 is higher than voltage V_2; and we say that a *potential difference* exists between V_1 and V_2. Thus current I flows from V_1 to V_2 through the four resistances shown.

The Electric Heating Forum is devoted to discussions of electric space heating practices and problems. This month a detailed analysis is given for computing heat-loss factors of constructions not appearing in published tables of U-factors. A knowledge of calculating procedures can aid also in appraising the value of various insulation thicknesses in both new and existing structures intended to be heated electrically.

Following this discussion, Floyd Olson presents an argument for electric utility participation in securing credit for the financing of electric heating installations.

Readers are invited to express their opinions; relate their own experience data to the material presented; or submit new ideas, research data, or case studies on any aspect of electric space heating. Please address correspondence to:

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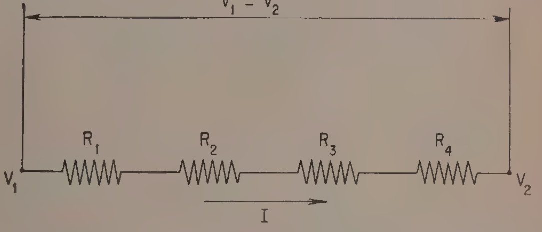


FIG. 1. CURRENT FLOW THROUGH ELECTRICAL RESISTANCE

A thermal circuit is similar. All building materials have a certain resistance to heat flow. Fig. 2 shows four such materials represented as resistances; U represents the flow of heat. Temperature T_1 (inside) is higher than temperature T_2 (outside); thus heat flows from T_1 to T_2. The *temperature difference* causing the flow of heat is equal to $T_1 - T_2$.

In Fig. 1, the total electrical resistance of the circuit is $R_1 + R_2 + R_3 + R_4$, and the value of current would be

$$I = \frac{V_1 - V_2}{R_1 + R_2 + R_3 + R_4}$$

In Fig. 2, the total thermal resistance of the building materials is also $R_1 + R_2 + R_3 + R_4$, and the flow of heat would be

$$U = \frac{T_1 - T_2}{R_1 + R_2 + R_3 + R_4}$$

Current flow is measured in coulombs/second, or amperes; heat flow is measured in Btu/hr. If $V_1 - V_2$ in Fig. 1 is unknown, we may say that

$$I = \frac{1}{R_1 + R_2 + R_3 + R_4} \text{ amperes per volt.}$$

Similarly, in Fig. 2 we may say that

$$U = \frac{1}{R_1 + R_2 + R_3 + R_4} \text{ Btu/hr per degree}$$

for each square foot of material we are considering. This quantity,

$$\frac{1}{R_1 + R_2 + R_3 + R_4},$$

is known as the U-factor, and it is expressed in Btu/hr per sq ft per degree temperature difference. To

THERMAL RESISTANCES

A. Air Spaces*

Position of air space	Direction of heat flow	Thickness of air space (in.)	Resistance (R)
Horizontal	Up	¾ to 4	0.85
	Down	¾	1.02
		1½	1.15
		4	1.23
		8	1.25
Sloping (45°)	Up	¾ to 4	0.90
Vertical	Horizontal	¾ to 4	0.86

*Bounded by non-reflective materials, effective emissivity = 0.82

B. Air Surfaces

Wind speed (mph)	Position of surface	Direction of heat flow	Resistance (R)
No wind; still air	Horizontal	Up	0.61
		Down	0.92
	Sloping (45°)	Up	0.62
	Vertical	Horizontal	0.68
7½	Any position	Any direction	0.25
15	Any position	Any direction	0.17

C. Insulation

Type	Material	Resistance (R) per inch thickness
Batts or blankets	Cotton fibre	3.85
	Mineral wool	3.70
	Wood fibre, multilayer	3.70
Loose fill	Macerated paper or pulp products	3.57
	Mineral wool	3.33
	Sawdust or shavings	2.22
	Expanded vermiculite	2.08
	Wood fibre (redwood, hemlock, fir)	3.33
Insulating board or slab	Glass fibre	4.00
	Cellular glass	2.50
	Corkboard (without binder)	3.70
	Hog hair (with asphalt binder)	3.00
	Foamed plastic	3.45
	Shredded wood (cemented)	1.82

D. Building Paper & Vapor Barriers

Material	Resistance (R)
Vapor-permeable felt	0.06
Vapor seal, 2 layers of mopped 15-lb felt	0.12
Vapor seal, plastic film	Negligible

E. Wood

Material		Thickness of heat path (inches)	Resistance (R)
Wood framing (soft wood)	1 x 2	25/32	0.98
	2 x 2	1 5/8	2.03
	2 x 3	2 5/8	3.28
	2 x 4	3 5/8	4.53
	2 x 6	5 5/8	7.03
	2 x 8	7 5/8	9.53
	2 x 10	9 5/8	12.03
	2 x 12	11 5/8	14.53
Plywood		1/4	0.31
		3/8	0.47
		1/2	0.63
		5/8	0.78
		3/4	0.94
Hardboard (fibreboard)		1/4	0.18
Soft wood (fir, pine, etc.)		25/32	0.98
		1	1.25
Hard wood (maple, oak, etc.)		25/32	0.71
		1	0.91

F. Plaster & Plasterboard

Material	Thickness (inches)	Resistance (R)
Cement plaster, sand aggregate	1/2	0.10
	3/4	0.15
Gypsum plaster, lightweight aggregate	1/2	0.32
	5/8	0.39
	3/4	0.47
Gypsum board (sheetrock; plasterboard)	3/8	0.32
	1/2	0.45

G. Masonry Materials

Material		Density (lb/cu ft)	Resistance (R) per inch thickness
Concrete	Sand and gravel or stone aggregate	140	0.08
	Gypsum fibre	51	0.60
	Lightweight aggregate	100	0.28
		80	0.40
		60	0.59
		40	0.86
		20	1.43
Cement mortar		116	0.20
Stucco		116	0.20
Brick	Common	120	0.20
	Face	130	0.11
Stone, lime, and sand			0.08

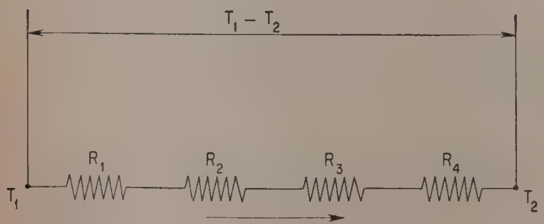


FIG. 2. HEAT FLOW THROUGH THERMAL RESISTANCE

find the U-factor, we need only to know the value of the thermal resistances R_1, R_2, etc.

These values are given in the accompanying tables for many of the materials used in the construction of buildings.

Use of Tables

Tables A through K show thermal resistances adopted for design purposes by the American Society of Heating, Refrigerating and Air Conditioning Engineers. The ASHRAE *Guide* contains a more extensive list; individual product manufacturers also specify material conductance values. (The conductance is the reciprocal of the resistance.)

Tables A and B require some additional explanation. In the passage of heat through a wall, for example, the heat must be transferred from the inside air to the inside wall surface, and from the outside wall surface to the outside air. The temperature of the inside wall surface is slightly lower than that of the air, and the outside surface temperature is slightly higher than that of the outside air. Therefore, some resistance to the flow of heat is offered by

H. Concrete Blocks (3-oval core)

Aggregate	Thickness of heat path (inches)	Resistance (R)
Sand and gravel	4	0.71
	8	1.11
	12	1.28
Cinder	3	0.86
	4	1.11
	8	1.72
	12	1.89

I. Flooring Materials

Material		Thickness (inches)	Resistance (R)
Tile	Rubber or plastic	1/8	0.02
	Asphalt	1/8	0.04
	Ceramic	1	0.08
	Cork	1/8	0.28
Linoleum		1/8	0.08
Terrazo		1	0.08
Wood floors	Hardwood	3/4	0.68
	Subfloor, pine	25/32	0.98
	Subfloor, plywood	5/8	0.78
Flooring felt			0.06
Carpet and fibrous pad			2.08
Carpet and rubber pad			1.23

J. Roofing

Material		Resistance (R)
Shingles	Asbestos-cement	0.21
	Asphalt	0.44
	Wood	0.94
Asphalt roll roofing		0.15
Built-up roofing, ⅜-in. thick		0.33
Slate, ½-in. thick		0.05
Sheet metal		Negligible

K. Siding

Material		Resistance (R)
Wood Shingles	Single, 16-in., 7½-in. exposure	0.87
	Double, 16-in., 12-in. exposure	1.19
	Plus insulating backer board, 5/16 in.	1.40
Wood Siding	Drop, 1 x 8-in.	0.79
	Bevel, ½ x 8-in., lapped	0.81
	Bevel, ¾ x 10-in., lapped	1.05
	Plywood, ⅜ in., lapped	0.59
Asbestos-cement, ¼-in., lapped		0.21
Asphalt roll siding		0.15
Asphalt insulating siding, ½-in.		1.45
Structural glass		0.10

both the inside and outside wall surfaces. This is known as surface resistance; values are shown in Table B. Note that a wind blowing across the outside surface will implement the transfer of heat from the surface to the outside air; thus the surface resistance will depend upon the wind speed. For inside surfaces, still air is assumed. For most design purposes, a 15-mph wind is assumed blowing across outside surfaces.

Similarly, an air space inside a wall has two surfaces at different temperatures which offer resistance to heat flow. For ordinary non-reflective building materials, the width does not materially affect the resistance of spaces from ¾ to about 4 in. wide—as long as the flow of heat is essentially in an upward or horizontal direction, such as through ceilings and walls. However, air spaces in floors present a higher resistance to heat flow downward, and the variation of resistance with the width of the space is significant enough to be recognized. These values are shown in Table A.

With the aid of Tables A through K, or similar tables obtained from other sources, the procedure for determining the U-factor of a given construction is as follows:

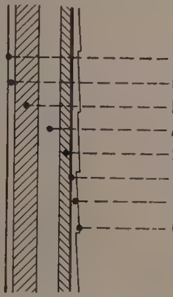
1. Ascertain the exact nature of the materials involved.
2. Make a cross-section sketch of the construction.
3. Find resistance values for all materials, air spaces, and surfaces from the tables.
4. Add up the individual resistances to find the total, overall resistance of the construction.
5. Compute the reciprocal of the total resistance. This is the desired U-factor.

Examples

Example 1.
The wall of a residence is constructed of 2 by 4 framing, using the following materials:

½-in. cement plaster on metal lath
Mineral wool insulating batts 2 in. thick between studs
1-in. wool sheathing
Building paper
Asphalt shingles.

Find the overall U-factor between studs.



	Resistance	Table used
Inside surface	0.68	B
Plaster	0.10	F
Insulation	7.40	C
Air space	0.86	A
Sheathing	0.98	E
Bldg paper	0.06	D
Shingles	0.44	J
Outside surface	0.17	B
Total resistance =	10.69	

$$\text{U-factor} = \frac{1}{10.69} = 0.094 \text{ Btu/hr/sq ft/deg TD}$$

Solution:
The cross-section sketch may be drawn with materials and resistance values indicated as shown. The required U-factor for the wall section between studs is thus 0.094 Btu/hr/sq ft/deg TD.

Example 2.
Express the U-factor of Example 1 in "watts" instead of "Btu/hr."

Solution:
In electricity, power is the rate of doing work and is expressed in watts. Thus the watt is the electrical equivalent of Btu/hr. One may be substituted for the other using the following conversions:

$$\text{watts} = \frac{\text{Btu/hr}}{3.413} = \text{Btu/hr} \times 0.293$$

$$\text{Btu/hr} = \text{watts} \times 3.413$$

Thus the electrical equivalent of 0.094 Btu/hr/sq ft/deg TD would be

$$\frac{0.094}{3.413} = 0.027 \text{ watt/sq ft/deg TD.}$$

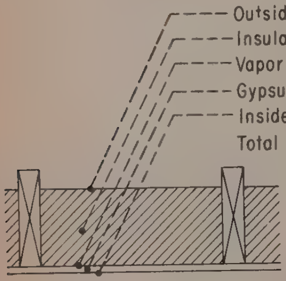
If it is desired to work completely with watts instead of Btu/hr, the U-factor in terms of watts may be found directly from the total resistance as follows:

$$\text{U-factor} = \frac{0.293}{\text{Total resistance}} \text{ watts/sq ft/deg TD.}$$

Example 3.
Since the depth of a 2 by 4 is 3⅝ in., the space between the studs in the wall of Example 1 includes a 1⅝-in. air space. What would be the U-factor of the wall if the 2-in. batts plus air space were replaced by a full 3⅝ in. of loose-fill mineral wool?

Solution:
In Example 1, the resistance of the insulation plus air space is 8.26. With the stud space completely filled with insulation, the resistance would be 3⅝ × 3.33 (Table C) or 12.10. This is 3.84 greater than the wall of Example 1; therefore the total resistance is 10.69 plus 3.84 or 14.53. The U-factor, then, would be the reciprocal of 14.53, or 0.069 Btu/hr/sq ft/deg TD.
Note: No attempt has been made here to name the unit of resistance. In electricity, resistance is measured in "ohms," or volts per ampere. Thermal resistance is similarly designated occasionally as "degrees per Btu"; although the term "rus", short for "resistance units," has also been advanced for consideration.

Example 4.
A frame ceiling consists of a plastic film vapor barrier stretched across the bottom of the joists and covered with ⅜-in. sheetrock. Loose-fill mineral wool 6 in. thick is blown between joists in the attic. What is the U-factor of the ceiling between joists?

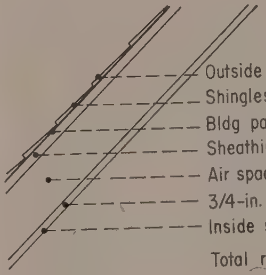


	Resistance	Table used
Outside surface	0.61	A
Insulation	20.00	C
Vapor barrier	Neglig.	D
Gypsum board	0.32	F
Inside surface	0.61	A
Total resistance	21.54	

$$\text{U-factor} = \frac{1}{21.54}$$
$$= 0.047 \text{ Btu/hr/sq ft/deg TD}$$

Solution:
The "outside" surface in this case is inside the attic space. Since the attic is essentially protected from the wind, the "still" air surface resistance is used. Also, since electrically heated, heavily insulated homes require liberal attic ventilation, no attempt is normally made to evaluate the resistance of the roof above the attic. Instead, the top of the ceiling insulation (or floor of the attic space, if any), is considered the outside surface, and the outside temperature is assumed to exist in the attic space. Adding the resistances in this case shows a total of 21.54, giving a U-factor for the ceiling of 0.047 Btu/hr/sq ft/deg TD.

Example 5.
NEMA suggests a maximum ceiling U-factor of 0.021 watts/sq ft/deg TD for electrically heated houses. What is the minimum thickness of mineral wool batts that must be added between rafters of the sloping roof illustrated to meet this figure?



	Resistance	Table used
Outside surface	0.17	B
Shingles	0.44	J
Bldg paper	0.06	D
Sheathing	0.98	E
Air space	0.90	A
3/4-in. plaster	0.15	F
Inside surface	0.62	B
Total resistance =	3.32	

Solution:
Using the relation expressed in the solution to Example 2,

$$\text{Resistance} = \frac{0.293}{0.021} = 14.00$$

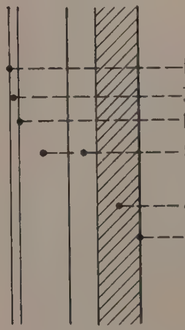
Resistance with insulation	14.00
Resistance without insulation	3.32
Difference	10.68

Therefore insulation having a resistance of at least 10.68 must be added. From Table C, mineral wool batts have a resistance of 3.70 per inch.

$$\frac{10.68}{3.70} = 2.9 \text{ or } 3 \text{ in. minimum.}$$

For existing uninsulated structures, installation of batts would be impractical. Usual practice is to fill the rafter space with loose insulation using pneumatic blowing equipment.

Example 6.
A wall is constructed without sheathing as shown in the sketch below to permit use of more insulation. What is its U-factor?



	Resistance	Table used
Inside surface	0.68	B
3/8-in. gypsum board	0.32	F
Plastic vapor barrier	Neglig.	D
5½ in. macerated paper insulation	19.64	C
4 in. face brick	0.44	G
Outside surface	0.17	B
Total resistance =	21.25	

$$\text{U-Factor} = \frac{1}{21.25} = 0.047 \text{ Btu/hr/sq ft/deg TD}$$

Solution:
The total resistance is 21.25; the U-factor is 0.047 Btu/hr/sq ft/deg TD. This construction has been used successfully in areas not subject to driving rains, where there is no danger of moisture penetration through the brick. Brick walls are fastened to the studs with metal ties; extra corner bracing is provided for structural strength.

Should the Utility Aid in Financing Electric Heat?

By Floyd Olson,
Electric Heat and Insulation, Salt Lake City, Utah

Efforts by the electric utility to help the small contractor secure sources of credit could prove beneficial to both.

FINANCING is probably the major problem facing a small company going into the business of installing electric heat in new construction.

Our company may be used as an example. On the average, our sales effort actually precedes completion of the job by about a year. In other words, the money we are spending today to talk to people, demonstrate the desirability of electric heat, and to promote our business cannot possibly come back to us in cash much before a year passes. This expense certainly limits the volume of business we can shoot at.

When the installation has proceeded to a certain point, we usually are able to draw some money. But the client (builder) is normally unwilling to pay to the extent of work accomplished to date, since he prefers to have some collateral as assurance that we will return to the job as each phase of construction is ready for us. Usually we cannot obtain a full settlement until the installation is complete and tested, which is months after our major commitment of material and labor.

Thus we find in operation that our earned accounts receivable average about 90 days' gross business, again a major factor in determining the volume of business that can be handled. Open accounts on material and insulating materials help, but we have to carry some inventory, plus quite a sizable investment in insulating equipment.

A bank loan may appear to be the proper approach. However, neither the jobs sold but not yet installed nor the earned profits on partially installed jobs are sufficient security for borrowing operating capital at the bank. We do feel, however, that they represent a substantial asset to the *electric utility* which is going to serve the load involved.

We believe, therefore, that the utility should, where necessary, aid in securing for the small electric heat installer a source of credit above and beyond what the local bank can provide based on mortgagable assets. To protect themselves, they should establish standards defining requirements they would expect of the installer desiring aid, including such factors as business experience, proven integrity, financial stability, sales organization, and willingness to guarantee performance.

Such a program would attract legitimate contractors and give the utility much better control of the quality of work being done. This would be a healthier approach from a standpoint of industry growth, product performance, and customer satisfaction than the practice presently encountered of fostering maximum competition to beat down the price and get more jobs on the lines. The inevitable result of price cutting is quality cutting, which is bound to be reflected eventually in the form of higher utility operating costs.

Electric Heating Films

Four sound slidefilms on electric heating have been produced by the General Electric Co. for use in consumer meetings and for installers of electric heating systems:

New Horizons—Why Millions Heat Electrically; 12 minutes; full color; Film No. 49-311; $15.00.

Describes baseboard heaters, embedded wire and wall-mounted units, and the exclusive advantages of electric heating systems.

Air of Satisfaction—A Cooling System That Heats Your Home; 12 minutes; full color; Film No. 49-312; $15.00.

Illustrates benefits of the heat pump, with a simple explanation of how it works.

Insulation and Design; black and white; Film No. 49-313; $12.50.

Covers factors influencing operating costs and conditions; how to properly insulate homes under construction and calculate system capacity.

Installation of Baseboard Heaters, Wall-Mounted Units, and Embedded Wire; black and white; Film No. 49-314; $12.50.

Shows step-by-step installation of three electric heating systems in new and existing homes.

Films may be ordered from the General Electric Co., 2100 Linden Rd., Zanesville, Ohio. Special prices are available for package orders.

NEMA Heating Symposium

The National Electrical Manufacturers Assn. has announced that the Second National Electric Space Heating Symposium and Exhibition will be held on March 19, 20, and 21, 1962, at the Hotel Sherman in Chicago, Ill.

Proceedings of the very successful First Symposium (see *Electrical Construction and Maintenance*, April, 1960, pages 73 and 279), have been published in the form of a 232-page handbook covering subjects which range from the selling and promotion of electric heat to technical discussions of insulation, control heat loss, and heating equipment. Copies are available at $5 each; 5 to 25 copies, $4 each; 26 or more, $3.50 each. Send orders to the Electric House Heating Equipment Section, NEMA, 155 E. 44th St., New York 17, N. Y.

American Airlines Specifies

High Level Hangar Lighting

Dual-reflector luminaires, equipped with color-corrected mercury vapor lamps, provide a uniform level of 65 footcandles throughout American's new hangar at New York's Idlewild Airport.

A LIGHTING level of 65 footcandles average has been installed in American Airlines' recently completed new airplane hangar at New York's International Airport at Idlewild. This is considerably higher than that in general use for this purpose, and is such that no portable stanchion lights are required, even for close-up mechanical work. Further, the lighting is of such uniformity that there are no discernible shadows beneath berthed planes.

Color-corrected mercury vapor lamps, in Holophane high-bay prismatic glass reflectors, were used to provide this high quality lighting job. These lamps are powered by 277-volt circuits fed from a 480/-277-volt bus duct.

The huge hangar building is large enough to shelter ten giant new jet planes simultaneously, and is integral with American's newly-built and recently-opened passenger terminal at Idlewild.

The overall hangar is 756 ft long by 356 ft wide. It is partitioned into three longitudinal sections by means of two interior walls. The two outer hangar sections, each 140 ft wide, are for planes, and the 74-ft wide center section is for offices, classrooms, and storage areas. The two partition walls are each recessed at five equi-spaced intervals to accommodate the noses of the 707 jets now being operated by American.

The roof is supported on cantilever trusses mounted on columns built into the partition walls. The lower members of the trusses rise from a height of approximately 32 ft at the partition wall, to approximately 44 ft at the outside wall. This high outside wall gives clearance for the tails of jetliners. Other relatively new Idlewild hangars have had to be altered to accommodate the high stabilizers of the new jets.

In planning the lighting system, a desired illumination level, the most suitable lighting equipment, structural restrictions, and maintenance requirements were all taken into consideration.

The desired illumination level was determined by airline engineers after conferring with their engineering consultants, and it was decided that a maintained uniform level of 60 to 65 footcandles would be specified for a location of 2 ft 6 in. above the hangar floor.

In selecting a lighting system for this project, lighting calculations were made for both fluorescent and mercury vapor lamp systems. These calculations indicated that for each 5-plane, 140-ft by 756-ft area, there would be required:

(A) 858 8-ft, 2-light, 1500-ma fluorescent luminaires, with a connected load of 412 kw, or

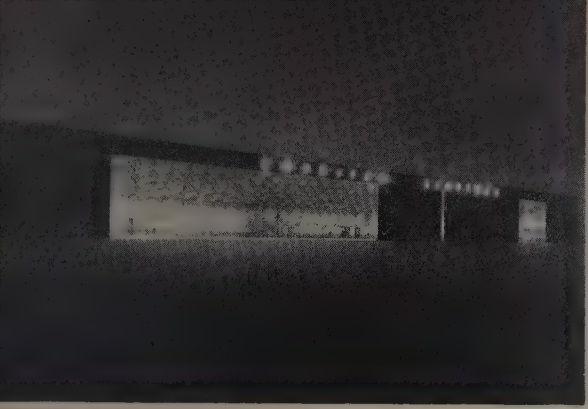
(B) 740 open bottom, open top prismatic glass high bay reflectors with one 400-watt color-corrected mercury vapor lamp per reflector, with a connected load of 333 kw. Based in part on this study, and in part on other factors such as ease of relamping, and estimated maintenance cost, the mercury vapor system was selected.

From a maintenance standpoint, it was decided to mount the reflector units in a fixed position, and to use a mobile elevating platform for lamp replacement and cleaning. Under operating schedules already adopted, burned out lamps are to be replaced monthly. With a total of 1440 mercury lamps involved, it is estimated that relamping can be handled easily by the regular maintenance crew.

In specifying the mercury vapor lamps, there was a choice between single 1000-watt units and twin 400-watt units. The economics slightly favored single units, but practical considerations pointed to the twin units. Structural members of the trusses made spacing of the 1000-watt units difficult—if spaced as required to provide the desired illumination, spacing would not be symmetrical and would conflict with structural elements in some locations. If spaced uniformly, more units than necessary would have been required. Therefore, twin 400-watt units were installed. The twin units have the added advantage of reducing the interception of light by planes in the hangar; the more lighting units there are, the less the obstruction of the light output by objects in the lighted area.

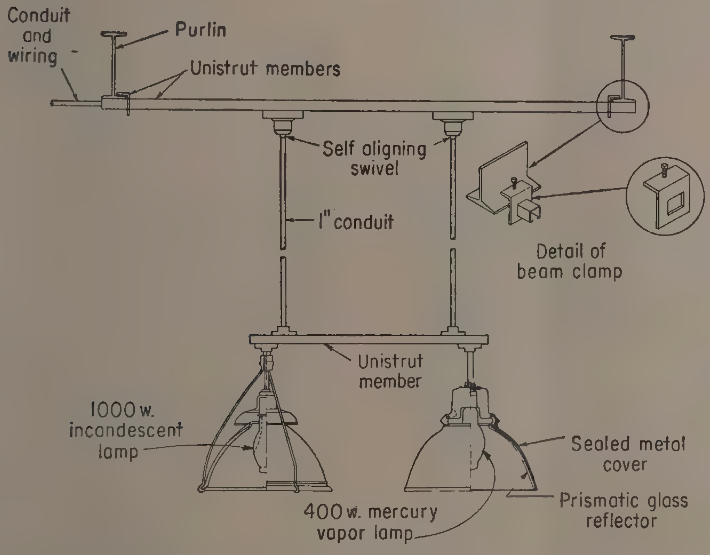
The lights were spaced on 20-ft centers across the hangar, but due to the location of 20-ft-on-center roof trusses and interconnecting members, they were placed on 15-ft centers in the lengthwise direction. They are at the same heights as the lower surfaces of the roof trusses. In most locations, the twin units straddle crossed struts which brace lower members of adjacent trusses. Nose-bay light spacing is the same as in the hangar proper.

Once this spacing was selected, the resultant illumination was checked by the "point-by-point" method of calculation. Total footcandles at selected points in a typi-

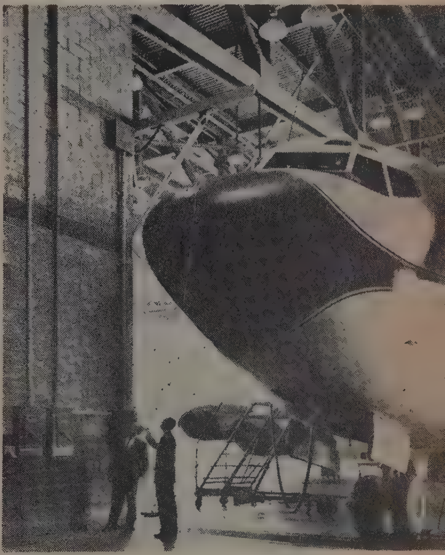


LIGHTING for American Airlines hangar No. 10, Idlewild Airport, New York City, is by 1440 400-watt color-corrected mercury vapor lamps in Holophane high bay prismatic glass reflectors. Lighting level is 65 footcandles.

TWIN REFLECTOR luminaires are spaced 20 feet apart across width of hangar, and 15 feet apart in each row along length of hangar. This over-all view is one of two sections, each 140-ft wide by 756-ft long.



TWIN REFLECTOR luminaire is supported from purlins by conduit and Unistrut members. Both reflectors are lamped with 400-watt mercury lamps except for certain luminaires which use a 1000-watt incandescent lamp in one reflector, powered by a special "night light" circuit. This permits a low level of general illumination when work light is not required.



NOSE of giant jet extends into wall partition recess so entire plane will fit into hangar. No auxiliary lights are required when working on plane, due to close spacing of high bay reflector units.

cal 200-square-foot area were calculated. These calculations, which were later verified with a cosine and color corrected illumination meter, indicated that the selected spacing was entirely satisfactory for meeting original design criteria.

Power for the installation is taken from a 480/277-volt bus which runs above the rooms of the center section. More than fifty 277-volt lighting circuits are connected with the main bus. Each circuit includes four to six twin high-bay prismatic glass reflectors and two-lamp regulated mercury vapor transformers. Five control panels are spaced along each partition wall so that lighting for given hangar areas can be controlled from within the area.

The mercury lights in a given location are operated only when an airplane is in this immediate zone. At other times, 1000-watt incandescent "night lights" provide sufficient illumination for "walk through" purposes.

The incandescent "night light" lamps replace a mercury vapor lamp in one of the twin reflector units at periodic intervals, and are on 60-ft centers in one direction and 76-ft centers in the other. They light up immediately when turned on, and do not require the brief warm-up period as is necessary for the mercury vapor lamps. The incandescents are on independent circuits, which are serviced from 277/115-volt dry-type transformers.

The luminaires, supplied by the Holophane Company, Inc., New York, N. Y., are of the high-bay type. The smooth interiors of the prismatic glass reflectors collect very little air borne dust, and are not affected by corrosion from the seashore atmosphere in which the hangar is located.

From the contractor's standpoint, and ultimately from the overall cost viewpoint, the luminaires selected also have the advantage of being easy to install.

Kahn & Jacobs, New York, were architects for this hangar building; Clifton E. Smith and Jaros, Baum & Bolles, New York, were consulting engineers; Turner Construction Company was general contractor and Lord Electric was electrical contractor.

High-Frequency Currents: Key to . . .

Vacuum Induction

High-frequency, vacuum induction, melting furnaces produce superalloys at the Metals Division, Kelsey-Hayes plant. Special equipment and installation techniques highlight the electrical requirements.

By **Robert J. Lawrie**, *Project Engineer, Metals Division, Kelsey-Hayes Co., New Hartford, N. Y.*

AT THE Metals Division, Kelsey-Hayes Company, New Hartford, N. Y., our entire function is the production of superalloys by vacuum induction melting. These superalloys include a variety of steels, pure elements and alloys to meet industry's increasing demands for high temperature, high strength materials.

Our seven vacuum induction furnaces have a monthly output of one million pounds of alloy, which represents over 50% of the total capacity of the vacuum induction melting industry. Because these furnaces operate on high-frequency power, the heart of our operations is an adequate electrical distribution system.

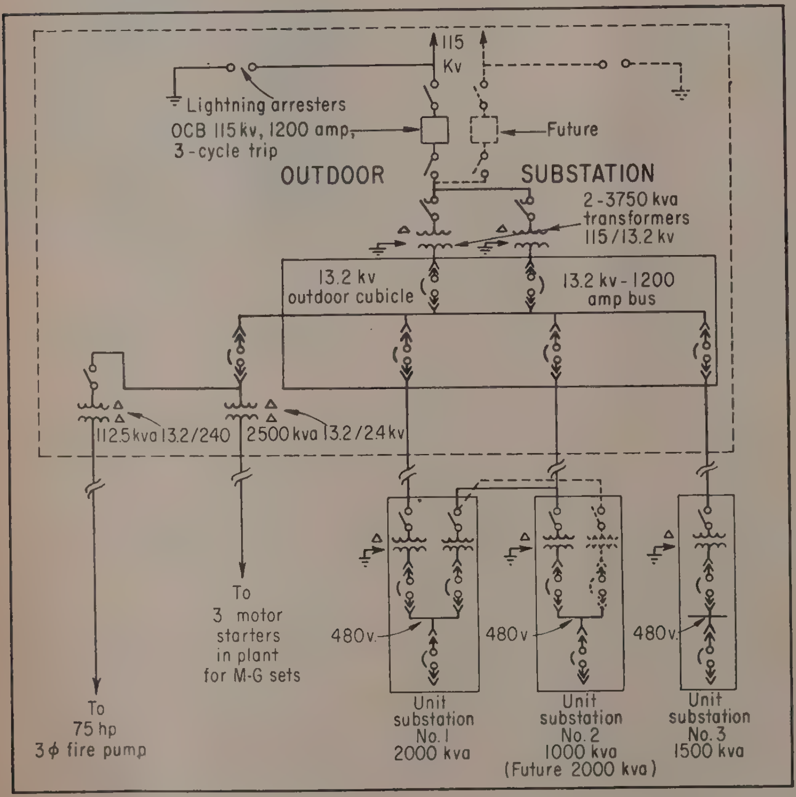

115 Kv
Lightning arresters
OCB 115 kv, 1200 amp, 3-cycle trip
Future
OUTDOOR SUBSTATION
2-3750 kva transformers 115/13.2 kv
13.2 kv outdoor cubicle
13.2 kv-1200 amp bus
112.5 kva 13.2/240
2500 kva 13.2/2.4 kv
To 3 motor starters in plant for M-G sets
To 75 hp 3φ fire pump
480v.
480v.
480v.
Unit substation No. 1 2000 kva
Unit substation No. 2 1000 kva (Future 2000 kva)
Unit substation No. 3 1500 kva

FIG. 1—Primary supply to outdoor substation is 115 kv. Two 3750-kva transformers handle present load requirements for high-frequency, vacuum induction furnaces. Provisions have been made for future plant growth. From the 13.2-kv outdoor switch cubicle, feeders supply three unit substations in the plant. Separate 2500-kva transformer provides 2.4-kv service for three M-G sets, which supply current to the large 5000-lb furnace. Feeders extend underground from the switchyard to the plant.

To maintain voltage stability for our present and future needs, we selected a utility primary supply of 115 kv, which feeds transformers with a total capacity of 7500 kva. This equipment, together with outdoor switchgear cubicles, is located in an outdoor substation close to the plant. From here three 13.2-kv feeders run to three unit substations in the plant. Also, two 2.4-kv feeders supply current to three large motor-generator sets for the operation of 1000-lb and 5000-lb furnaces. Fig. 1 shows a one-line diagram of the primary and secondary distribution system.

While our seven induction furnaces vary considerably in mechanical and electrical design, the basic electrical principles are the same. Induction melting is the result of the I^2R loss caused by induced currents in the charge (material placed inside the coil). And the coil produces a varying magnetic field, directed alternately upward and downward. This action can best be thought of as if the coil is the primary of a transformer, and the charge is the secondary with a short-circuited single turn. Circulating currents (or eddy currents) generate heat because of the I^2R losses. And high-frequency current speeds up the melting process, because of the well known skin effect.

10,000-Cycle Furnace

Our smallest furnace (18-lb capacity) is essentially composed of 1) a furnace chamber which contains an induction unit; 2) molds and additions maker; 3) vacuum pumping system for evacuation of air from the chamber; 4) power

Heating

supply; 5) capacitor bank; and 6) auxiliary equipment.

The furnace chamber is a cylindrical tank on a vertical axis and about 2 ft in diameter by 3 ft high. It houses the induction melting unit (crucible), molds and additions maker. As the heart of the vacuum furnace, the crucible holds the molten bath, to which additions are made at the precise time. After the melt, the unit tilts and pours molten metal into the molds. Later, the ingots will be rolled into barstock or sheet.

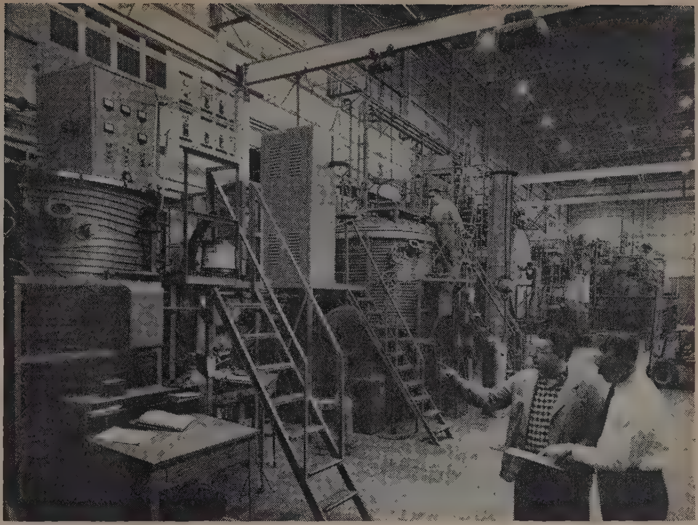
Construction of the 18-lb crucible is comparatively simple, with an aluminum frame of bolted construction holding the coil. To avoid induction heating of the frame, all joints are insulated with Transite or Synthane. Water-cooled, the copper coil is wound in a single circuit of four turns. Refractory material insulates each turn of the $\frac{5}{8}$-in. copper tubing.

Furnace power supply for the 18-lb unit comes from a motor-generator set with a generator output of 50 kw, 0-200 volts at 10,000 cycles. Power output can be varied at the generator control panel by an operator, who constantly observes voltmeter, ammeter, kw and kvar meter readings. From observing these readings, the operator can make precise adjustments according to need. Other equipment mounted in the generator control panel includes overcurrent relays, voltage regulator and temperature relays.

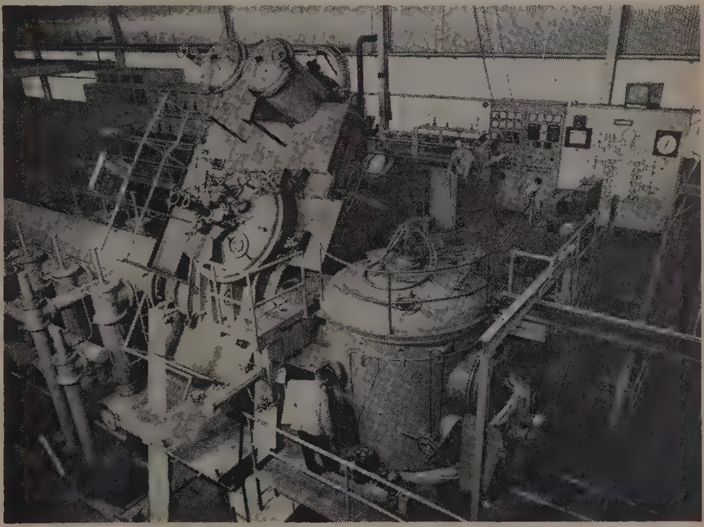
High-frequency output circuits require special attention because of several factors not prevalent with dc or low-frequency ac currents. At high frequencies, the current tends to be concentrated near the surface of a conductor. This is due to "skin effect," which increases proportionally with the frequency. Because of this condition, we use very fine stranded welding cable for the output circuit from the generator. Because it has more current-carrying surfaces, this type of cable is more suitable for such applications. As a result of skin effect, the ampere rating of the cable must be reduced approximately one-third at 1000 cycles; one-half at 3000 cycles; and two-thirds at 10,000 cycles.

Also important is the lay of conductors, and such configurations are shown in Fig. 2. This arrangement aids in canceling the adverse effect of the magnetic fields. If this is not done, high line losses will occur. From the main contactor, water-cooled copper busbars carry current to the work coil. Here again, due to skin effect, we use wide, thin bus bars (3-in. by $\frac{1}{4}$-in.). Also, care must be taken to place the bus bars as close together as possible to reduce inductive reactance losses.

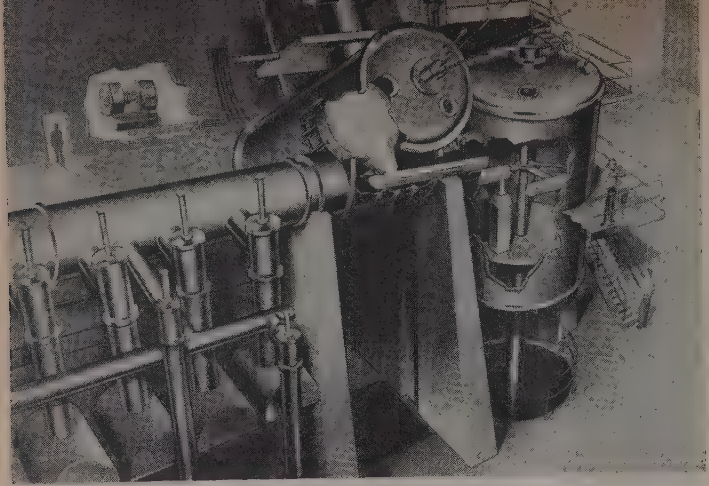
To correct the lagging power factor, caused by the inductance of the work coil, four 100-kvar capacitors can be paralleled with the coil. By changing tap settings, different



GENERAL FURNACE AREA includes six vacuum induction furnaces, ranging in capacity from 100 lb (foreground) to 5000 lb (rear right.) Two unit substations, 1500 kva and 2000 kva, can be seen on the balcony at each end of the photo. Aluminum interlocked armored cables, rated at 15 kv, provide the primary supply for the unit substations, and they are installed in horizontal cable-supporting ladders.



POURING 5000 LB of vacuum induction melted alloy is a precise operation. Intricate control measures assure perfect pouring. Notice that the entire furnace tilts when pouring. In the upper right hand of photo, technicians are checking readings of instruments on the furnace control panel. Below, technicians are examining the pouring operation in the mold chamber. All four operators wear intercom head sets to relay information for proper control adjustments, when needed.



CUTAWAY VIEW of 5000-lb furnace shows essential parts of the pouring operation. M-G sets in room behind furnace supply 890-cycle current for melting and 30-cycle current for stirring the melt. Note flexible power leads, which allow entire furnace to tilt. Several motors supply hydraulic systems, which tilt the furnace, and raise or lower the mold table (at the right). After pouring is completed, mold table lowers to floor level, where molds are removed.

values of capacitance can be connected into the circuit, depending on the inductive load.

Another important function is the vacuum system. Vacuum is required to remove contaminating gases, which adversely affect the high-temperature strength of metals. Through a 3-hp mechanical pump and a 1-kw diffusion pump, furnace chamber pressure is reduced to 1-10 microns.

3,000-Cycle Furnace

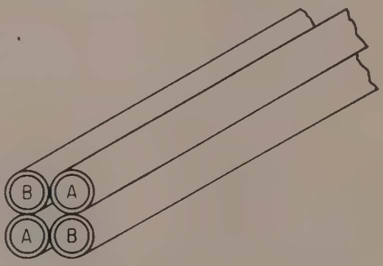
As the furnaces increase in size and capacity, they become increasingly complex. Our 1200-lb furnace has a horizontally mounted, cylindrical chamber, 9 ft OD by 11 ft long, and is of double-wall construction for water cooling. The induction coil is 24 in. by 24 in. high and has eight parallel circuits of two turns, each terminating at bus bar contacts where cooling water enters and leaves. A 500-hp motor, 440 volts, 3-phase, drives a single-phase generator, rated at 300 kw, 0-600 volts, 3000 cycles. For circuit impedance matching, a variable autotransformer is connected after the main contacts. And 4200 kvar of parallel capacitors can be switched into the circuit as required.

For this furnace, the vacuum pumping system consists of six 12-kw diffusion pumps, two 25-hp mechanical pumps and one 3-hp pump. And in addition, a pump control panel houses contactors for the diffusion pump, valve controls, pressure gages, temperature gages and recorders, safety warning devices, and miscellaneous controls. Powered by a 7½-hp motor, a hydraulic system tilts the crucible after the melting process.

5000-Lb Furnace

Our 5000-lb furnace, at present the largest of its kind in the world, was conceived by Metals Division engineers. To design and engineer the electrical portions of the furnace, we selected a prominent manufacturer from Vasteras, Sweden, because of the Swedes' extensive experience with high-frequency induction furnaces. As a result, this furnace, including three M-G sets, transformers, control equipment and overcurrent devices, is of Swedish design. The vacuum system and much of the miscellaneous equipment was manufactured in the United States.

This huge furnace can draw a maximum tank circuit current of about 28,000 amps, with a total power consumption of 1300 kw. Previously, no one had attempted to build a furnace with such rigorous requirements for operation in a high vacuum. We had to solve several installation and operating problems. But before explaining them, a brief description of the furnace is necessary.



Arrangement of parallel cables for high frequency output circuits.

FIG. 2—Cable configurations are important considerations for high-frequency circuits. Alternately arranging conductors as shown aids in canceling the adverse effect of the high-frequency magnetic fields. This reduces inductive reactance losses, which minimizes line losses.

Essentially, the furnace consists of a melt chamber, mold chamber, pumping system, power supply, hydraulic system and miscellaneous auxiliary equipment. Located adjacent to the furnace is a 4000-sq-ft motor-generator room for power supply and related apparatus.

The water-cooled melt chamber measures 6 ft by 12 ft and is supported on two hydraulic cylinders, which also tilt the entire chamber. After a hydraulic ram lifts the crucible into the melt chamber, the bottom cover is bolted on. Then eight water-cooled, 1000 MCM, flexible power leads are attached, and the ram recedes into the floor.

Rectangular copper tubing, 1½ in. by 1 in., forms four parallel circuits of five turns each for the water-cooled work coil, which measures 33 in. by 43 in. In addition to supporting the coils, silicon iron laminations contain the high-frequency flux produced by the coils.

In the mold chamber, several molds are placed on a mold table, which can be rotated by remote control. When molds are positioned at floor level, a hydraulic ram, driven by a 40-hp pump, lifts the table into position. Then, control devices automatically level the table.

Operating vacuum in the mammoth furnace compares to that of a vacuum tube. For the vacuum pumping system, we use 12 36-kw diffusion pumps, five 25-hp mechanical pumps, and two 3-hp mechanical pumps. All pumps can be valved into a main manifold via remote-controlled poppet valves, as needed. Thermostats control the water-cooled diffusion pumps; and flow switches, pressure switches and overcurrent relays provide protection for the pumps. At the pump control panel, the entire system is controlled and monitored. This makes it possible for the furnace

TWO SHUNT-CONNECTED, 550-kva, 440-volt, 890-cycle, single-phase generators, driven by 600-hp, 2.4-kv, 3-phase wound-rotor motors, supply 1100 kva of power for the melting process of 5000-lb furnace.

NEW INSULATION is applied to coils of induction unit, which holds metal for melting by high-frequency current. Coils are copper tubes and are cooled by water continuously flowing through them.

operator to read thermocouple-type pressure gages, which indicate pressure at nine different points in the furnace chamber and pumping system. In addition, a recorder plots the pressure throughout the melt cycle, and another recorder indicates the temperature of the molten bath.

Two shunt-connected, 550-kva, 440-volt, 890-cycle, single-phase generators, driven by 600 hp, 2.4 kv, 3-phase wound-rotor motors, supply the power for melting. Because the rotor of a high frequency generator is quite heavy, engineers selected the wound-rotor motor as it has a high starting torque.

For mixing the molten bath, a third M-G set provides 30-cycle current. When applied to the coil, this low-frequency current produces a mixing action in the molten bath. This effectively carries harmful gases and contaminants to the surface, where they are evacuated from the melt. With a power factor of only 20%, the 800-kva, 600-volt, 30-cycle, 2-phase generator required a 200-hp motor to drive it.

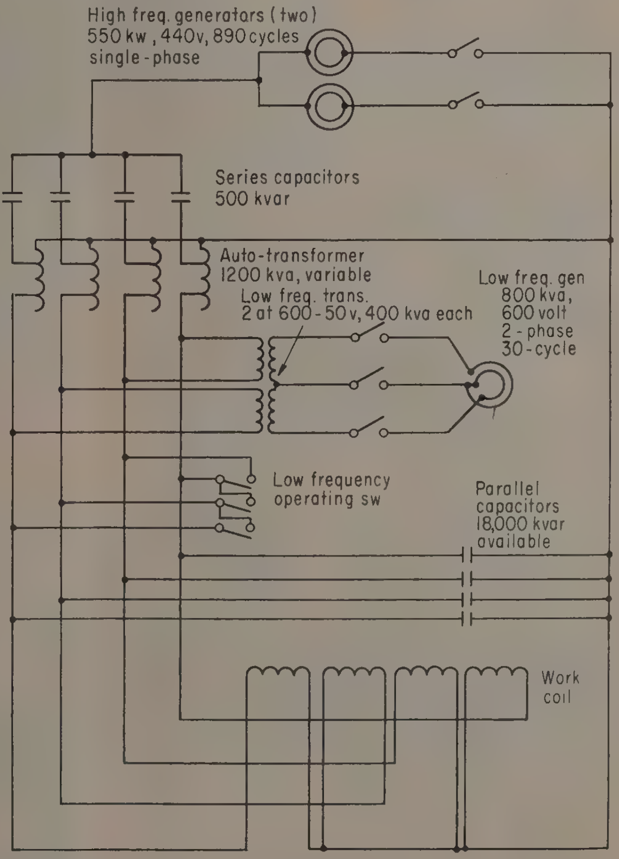
A complex bus bar system carries high-frequency current from the generator—through series capacitors, an autotransformer and a parallel capacitor bank—to the point where the flexible power leads connect to the coil. Besides blocking the 30-cycle power from the 890-cycle generators, the series capacitors help to correct the power factor.

Impedance matching is accomplished with a 1200-kva autotransformer. Ratios of 600 to 600-750-900 can be obtained through remote control operation. This air-cooled transformer is in a separate fireproof room, and integral relays protect the transformer from overloads.

To correct the very low power factor, 18,000 kvar of parallel capacitors can be switched into the circuit as required. Internal fusing of the Swedish-made capacitors practically eliminates serious shorts. And overcurrent/overvoltage relays give added protection.

Several thousand feet of ¼-in. by 12-in. bus bars form a geometrical jungle of copper. To handle the high circulating-tank-circuit current, eight bus bars run in multiple. Additional runs are required for the low-frequency stirring current.

[Continued on page 190]



DUAL FREQUENCY POWER CIRCUIT - 5000 LB. FURNACE

FIG. 3—Sketch shows equipment and circuit arrangements for the dual-cycle power wiring, which supply the world's largest vacuum induction furnace. Circuit for melting is 890 cycles, and 30-cycle current stirs the molten bath to remove impurities. Series capacitors block 30-cycle current from the 890-cycle generators. Other capacitors and a variable autotransformer match impedances according to load requirements during each melt cycle.

Methods Make the

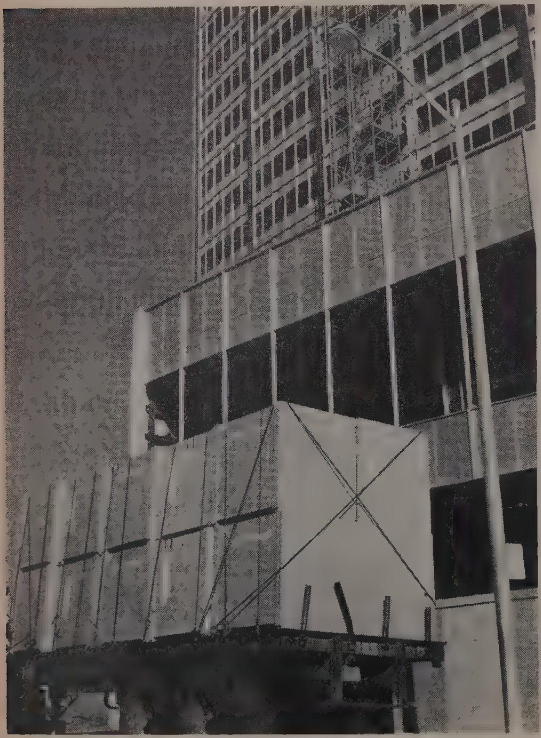
Practical production-line techniques simplified installation of 24,000 luminaires in California office building, while cooperation between contractor and equipment suppliers reduced time and effort.

By Lawrence H. Hultgren, *Senior Engineer, Foothill Electric Corporation, Oakland, Calif.*

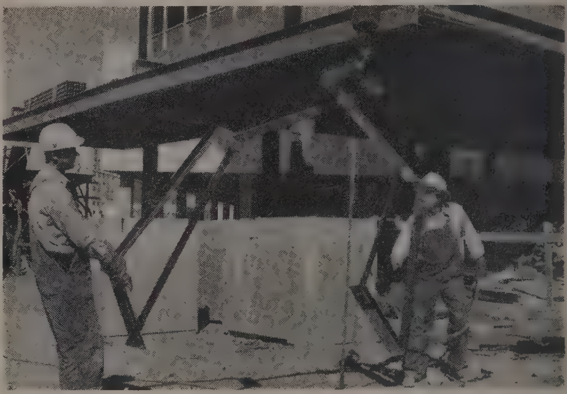
LIGHTING and wiring a million-sq-ft office structure having 14,000 luminaires built into an acoustical ceiling demonstrated that even small efficiencies in oft-repeated procedures can effect impressive overall savings of time and effort. And, while "large jobs are merely summations of many smaller jobs," it is obvious that many methods devised for large-scale use can readily be adapted to practical service on less-spectacular jobs as well.

This certainly is true in connection with procedures developed for use on the new Kaiser Center in Oakland, Calif., where mass-assembly techniques were applied abundantly, and where several job-site procedures practically maintained the uninterrupted continuity of factory production-line sequences.

Take for example the delivery and installation of lighting fixtures, as illustrated by the accompanying photographs.



FLATBED TRUCK delivered crated lighting fixtures to project site; each case containing 21 two-lamp luminaires and labeled for delivery to specified floor in accordance with master shipping schedule. Arrivals of trucks were scheduled so that fixtures were delivered as needed, eliminating necessity for central storage area with related chore of double handling.



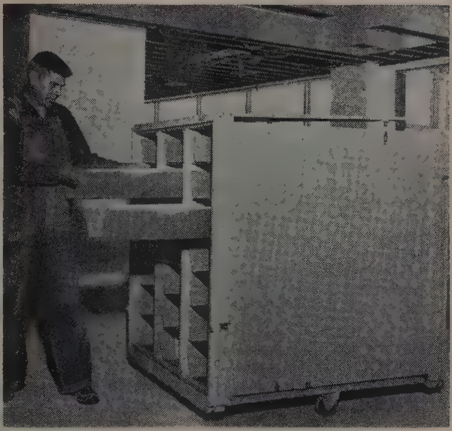
ANGLE IRON FRAME constructed on principle of ice-tongs was used to grip and hoist fixture crates to designated floors; a boom-crane overhanging the roof parapet of the 28-story building being used as the hoisting power medium. Note pivoted arrangement of tongs, whereby downward weight of crate tends to tighten inward pressure of side frames.

TONGS WERE USED to unload fixture crates from trucks to ground-level platform. There they were placed on dollies, rolled onto a hoisting cage and raised to the desired floor. They were then rolled off the hoist cage and wheeled directly to the floor area where installation work proceeded.

Difference

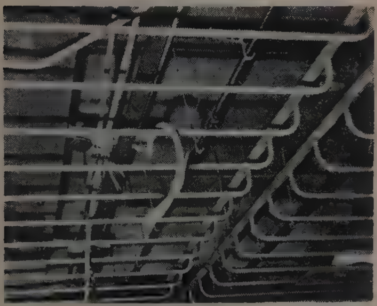
TONG LEGS WERE SPREAD so that frames could slide down over sides of fixture crates. Then, with crate supported by bottom lips of side members. signal was given to "hoist away." Note nest of plywood dollies in foreground; each dolly dimensioned to match bottoms of identical crates, also equipped with four casters each to permit maximum turning and rolling ease when in use.

WITH DOLLIES IN PLACE beneath designation-tagged crates, boxes were moved directly from window-wall swing-in receiving point to exact position where fixtures were to be installed. This procedure again eliminated intermediate local storage and double handling of luminaires, while constant containment in cases provided fixtures with maximum protection against damage during shipment.

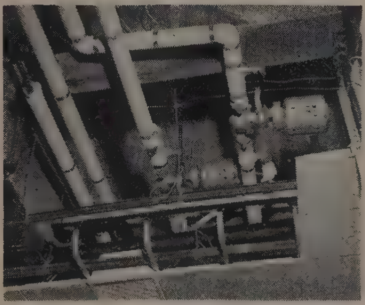


PIGEONHOLE CONSTRUCTION of plywood crates is indicated by this unloading action shot. As noted, individual fixtures were additionally protected by corrugated cardboard sleeves. With hinged front panel of crate unlatched and flipped up and backwards, fixtures could be removed with maximum speed and ease, after which empty crates were returned to manufacturer for reuse.

TWO-MAN TEAM was formed to minimize waste motion; one worker removing fixtures from crate and passing them up to teammate who clipped them into position and connected branch-circuit leads. Specially designed for this project under the name of Stargazer, fixtures are shallow-recessed 2-lamp units equipped with spring side lips that snap over pipe-grid forming radiant-ceiling framework.



RADIANT CEILING grid consists of series of large-diameter supply and return header pipes, with smaller-diameter pipes welded to same and extending at right angles to provide multiple flow channels for circulation of hot or cold water, depending upon season, winds, and intensity of outdoor sunlight. Zone control is instrumented by local circulation pumps and thermostats.

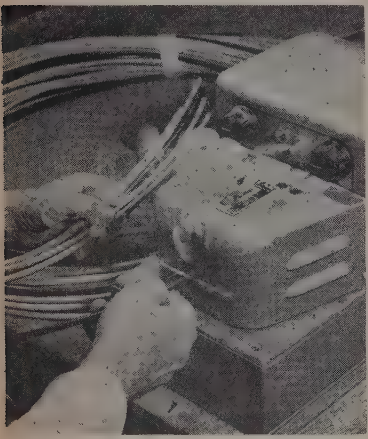


CONSTRUCTION VIEW clearly shows radiant pipe grid, with circulation pumps and water mains above, and with lighting fixtures and acoustical panels snapped into place beneath them. Note that fixture has been equipped with distinctive small-cell aluminum light-shielding louvered bottom panel. Operation of lighting is at 277 volts, derived from a 480 Y/277-volt supply.

IN ADDITION to year-round temperature uniformity obtained by regulating flow of hot or cold water through radiant-ceiling grid, fresh-air ventilation is provided by means of insulated ducts, flexible vibrationless sleeves and adjustable perforated flow-ports. Ventilation grille is dimensioned to snap over same basic grid that supports lighting fixtures and acoustical ceiling panels.

BRANCH CIRCUITING for 24,000-fixture lighting system consists of No. 10 aluminum wire. And, since installation patterns are repeated countless times throughout this mammoth office structure, mass-assembly methods were advantageously used for pulling-out, measuring and cutting equal-length leads. To augment this operation, special reel rack was used as shown.

CUTTING RIG, operated by foot pedal, was positioned atop plywood work table so that, when bunched group of nine conductors was pulled from reels (in background) and carried out to front edge of table, required lengths (with slight surplus) would be automatically measured, then cut as a group. This multiple operation was fast routine with 2-man crew.



STRIPPING LEADS was accomplished quickly and safely by means of electric nicking method; heated, rounded low-pressure blades closing upon, melting and stripping insulation in a single, fast operation. Note various dials, levers and gauges to regulate temperature of unit, on-off circuiting of device, and length of end-stripping. Without sharp insulation-cutting blades, nicking of conductors was avoided.

EMT related to fixture circuits was likewise cut in production-line operation, equipped with end connectors and bunched for delivery to specific area on upper floors. Note simple cradle formed from 180-degree bends of EMT and supporting framework of lipped channels. With all components prefabricated, installation and final connections were greatly simplified.

PIGTAIL CONNECTIONS of aluminum branch circuit wires were made with use of insulated Scotchlok type connectors containing internal coiled-spring construction. Small amounts of high-viscosity petroleum compound and sealing paste were first squeezed directly into connector caps to insure positive contact between conductors.

CONTACT AREAS between branch-circuit conductors were brought into intimate contact by contractive force of springs inside insulated connectors. With strong-coiled internal springs resisting any tendency to loosen or relax grip, good connections were consistently obtained. Terminal connections of branch circuiting in distribution panels were made by "laying in" eye-loops.

• *ESTIMATING FORUM—III*

It Costs Money to Switch To "Unfamiliar" Work

By Ray Ashley, *Research and Consulting Engineer, Oak Park, Ill.*

STATEMENT:

Electrical contractor James specializes in residential wiring. He enjoys an annual volume approaching $500,000 and normally employs an average crew of 30 men. He was asked to figure the electrical work (estimated cost, about $200,000) for a factory addition. A friend with the firm erecting the building assured James preferential treatment to the tune of $5,000 more than the lowest bid if he would do the work. Despite this inducement, James refused to figure the job.

QUESTION:

Did James do the right thing in passing up this sizable job with the inducement that went with it?

ANSWER:

Yes. James had neither the equipment nor the organization to handle this type of work. It would cost him more than the $5,000 "premium" to overcome the advantages of more qualified contractors.

DISCUSSION:

There were many reasons why James should not figure this job. An industrial project of this type normally would have to be completed in 150 days. This would require an average crew of at least 15 electricians and a peak of about 25 men. Manpower for his regular work could not tolerate such dilution. Even if he could swing it, it would be hard to find many first rate industrial wiremen among his specialized residential crew. If he had to rely on a pickup crew for this job, there would be inherent excess labor charges.

Other excess costs for estimating, engineering and tools would be encountered. Chances are he would have to use outside estimating and engineering services. His costs for this would be considerably higher than that of contractors using their own organization personnel. Tools for residential work are of a limited type. Proper tools for a sizable industrial project would require a

(*Continued on page* 162)

Fig. 1—NORMAL ESTIMATE FOR THE INDUSTRIAL PROJECT

(Contractor organized and equipped for the job)

	MATERIAL		LABOR
Base costs (material purchase)	$96,000	(Payroll)	$64,000
Direct job expense (material) 2%	1,920		
Direct job expense (labor) . . . 6% of 64,000	3,840		
Total direct job costs	$101,760		$64,000
Overhead and management 4%	4,070	16%	10,240
Complete job costs	$105,830		$74,240
Return 5%	5,291	10%	7,424
Sell price—Material	$111,121		$81,664
Sell price—Labor	81,664		
Sell price—The Job	$192,785		

Fig. 2—ESTIMATED EXCESS EXPENSES JAMES WOULD ENCOUNTER

(If he were to do the industrial job)

Excess labor (5% of $64,000 base labor cost)	$3,200
Excess estimating and engineering (1% of $160,000)	1,600
Tools purchased for special project	2,000
Total excess expenses	$6,800

NOTE: The excess labor costs might run higher.

FISHERMAN'S WHARF MOTEL has full electrical convenience. Outdoor lighting includes m-v units for parking area; inverted "bullets" to highlight underside of unique zigzag roof; underwater lighting of pool behind stone wall; illuminated room numbers.

Luxury Motel Goes All-Electric

Full electrical convenience including heating and cooling complements the luxurious appointments at Fisherman's Wharf Motel in St. Clair, Mich. Centralized master indicator panel gives manager finger-tip control.

By **W. T. Gove,** *Market Manager Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.*

ELECTRICAL CONTRACTOR Ross Neal, Port Huron, Mich., is proud of the motel electrical system he installed and helped design. He points out master control facilities in motel office.

ALL-ELECTRIC convenience with the ultimate in efficient system and operational control is an apt description of Cunningham's new Fisherman's Wharf Motel in Michigan. Nestling in the sloping bank of the St. Clair river some 60 miles north of Detroit, the 21-unit, 3-level, brick and fieldstone structure exudes quality, comfort, luxury and convenience throughout.

The $300,000 project is built adjacent to an existing Cunningham restaurant and lounge. In addition to the spacious guest units, it includes a large meeting room; motel office; 3-room manager's apartment; outdoor swimming pool and well-lighted parking area.

Owner Stew Cunningham worked closely with Royal Oak architect George Lytle and Port Huron electrical contractor Ross Neal to build the type of motel he wanted—luxurious comfort and convenience for guests and efficient operation and maintenance for management. Individual room electric heating and cooling and fire detection with centralized office control highlight the pace-setting design.

Room Electrical Features

Each guest unit has a Thermopane window wall facing the river; wall-to-wall carpeting; walnut paneling and silk wallpaper; acoustic tile ceiling; folding door screen separating main room from guest bar, dressing alcove and bath. Complementing this "plush" decor are the following electrical features:

Baseboard electric heating with individual thermostatic control of main room and bath.

Built-in air conditioner with integral temperature control.

Sensing unit for fire alarm system.

Hushed mercury switches for all room lights.

Piped-in radio programs with individual station selector and volume controls.

MASTER CONTROL CONSOLE behind registration desk is nerve-center of operating efficiency; provides finger-tip control of all electric facilities.

BEDSIDE PANEL has soft "morning call" buzzer with acknowledge button; desk message signal light; and switches to control reading lights and television.

BASEBOARD ELECTRIC HEATING units under window wall are controlled by room thermostat and master switch in motel office. Separate thermostat controls bathroom electric heating.

INTERIOR OF GUEST UNIT contains luxurious appointments and convenient electrical circuit controls. Note sensing unit of fire detector (arrow) in acoustic-tile ceiling.

Bedside control panel with switches for reading lamps, television set, "morning call" buzzer, and a "guest message" light.

Built-in ironing board complete with electric steam iron, fold-away switch control and a time-delay switch to shut off iron after 30 minutes.

Electric Heat Features

Based on 6,600 degree days and a design temperature range of −10°F to 70°F, calculated heating loss for the motel structure was 92.2 kw. Total connected electric heating load is 111.5 kw. Walls are insulated with 4 in. of mineral wool; ceilings have 6 in.; floors have 2 in. of rigid insulation.

The main room of each 16-ft by 28-ft guest unit is heated by high-wattage baseboard panels located under the windows. Most of them total 3,900 watts. Two are 3,700 watts and one, 4,400 watts. A low-voltage thermostat controls room temperature when the unit is occupied.

Each bathroom has a separate thermostat controlling a 500-watt baseboard panel and 400 watts of radiant heating cable buried in the tile floor.

Like the guest units, the 17-ft by 23-ft motel office has baseboard heating units totaling 5,600 watts. The manager's apartment—living room, bedroom, kitchen and bath—has a similar heating system totaling 7,300 watts. And the 23-ft by 32-ft meeting room above the office has 8,500 watts of heating capacity.

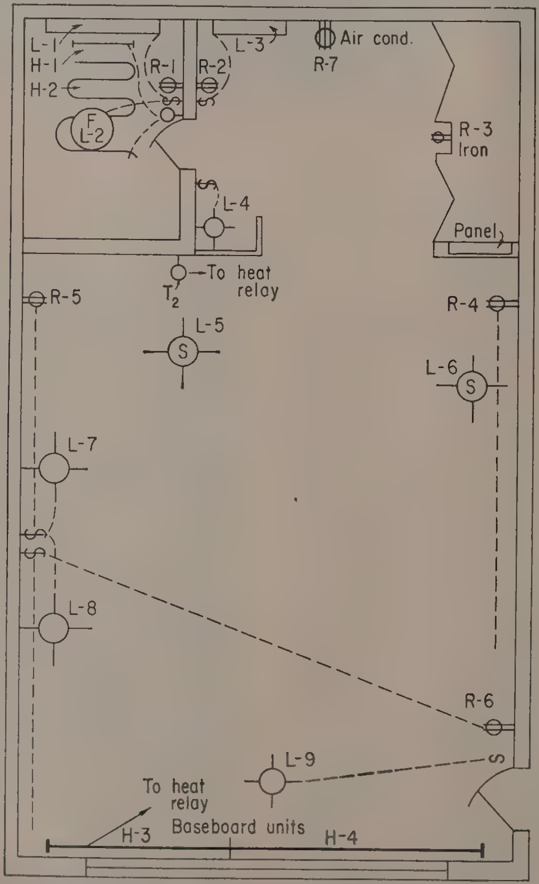
Cunningham likes his electric heating system because it is clean, quiet and requires no maintenance. Money can be saved on expensive redecoration and system repairs. While an acknowledged operating-cost differential exists between heating kilowatts and other fuels, he estimates it will take a good many years for this additional cost to equal the savings he pocketed on original installation. And there is this additional economy "plus." Cunningham pays only for the heating kilowatts actually used by the guests. With his central control, he can cut the heat back to 45° in any unoccupied unit by merely pushing a button on the office panel; boost it up to 70° when a guest registers. Because of the well-insulated design, Cunningham figures it takes half a day for a unit to cool down to 45° when set back, even in bitter January weather.

Master Control Center

The entire motel is controlled electrically by a Motel-Master indicator panel immediately behind the registration desk in the office. From this point the manager can turn on or off the heat and electricity in any guest unit; check the temperature in each room; signal a guest for morning wakeup or a message at the desk; see which units are occupied or vacant; im-

MAIN SERVICE and distribution board in basement room is of 2,000-amp capacity. Blank spaces in the 120/240-volt, 3-phase, 4-wire panels are for 24 motel units to be added later.

BUILT-IN IRONING board in dressing alcove folds up into closet. Integral electric steam iron has automatic shut-off when board is folded, or after 30 minutes use.



ELECTRICAL LAYOUT for typical motel unit. Note individual thermostats for bedroom and bathroom heating.

mediately detect a fire should one occur. Also on this panel are a temperature indicator dial and a fire alarm silencer button.

On the sloping console under the panel are two rows of control buttons, one row above and one below the room key compartments. There are five buttons for each guest unit.

The first button is pushed when a guest registers. This lights up the yellow "room status" light on the panel; also turns on the room power to lights, TV, air conditioner, iron and other appliances. The clerk pushes this button again when a guest leaves. This turns off the "status" light and cuts off all electric power to that unit—a quick and easy way to shut off any lights or electrical equipment the guest may have inadvertently left on.

The second button turns on the heat in the unit to 70°. The guest then controls room temperature with the thermostat. When he leaves, the desk clerk pushes the master button again to throttle heat back to 45°.

The next button actuates the soft "morning call" buzzer to awaken the guest. He turns it off at his bedside control panel.

The fourth flashes a green light on the bedside panel to indicate a mesage for the guest at the office.

The fifth is a button to check room temperatures. A sensing device in each room is connected to the temperature indicator dial on the office panel. Room temperatures are always checked when a guest registers.

A red fire-alarm light is under each room "status" light on the panel—one for each guest room. These are connected to a fire detector unit in the room ceiling and flash if room temperatures go over 130°, simultaneously setting off a fire siren. To date, the siren operated only once—when two happy guests held a lighted cigarette to the sensing unit to see what would happen. They found out.

A maid control light is an added feature. When a maid enters a guest room she operates a special key-switch to turn on a signal light in the office. Removal of the key when she leaves turns off the signal.

Service and distribution equipment is located in a basement room. The 2,000-amp, 120/240-volt, 3-phase, 4-wire, bus-bar type installation is reportedly the largest non-factory service in that part of Michigan. Distribution facilities associated with the service have built-in spare capacity for 24 additional motel units planned.

In addition, there is a load center in the manager's apartment. All heat-control relays are mounted in a special cabinet on the opposite side of a partition from the load centers supplying the heating circuits. Each motel unit has its own heating, air conditioning, lighting, and general-use circuits.

To date, this 12,000-sq-ft motel was the largest electric heating installation for electrical contractor Ross Neal. Previously he had 20 homes and a 6-unit apartment project to his credit. Despite the size and unique control features, he reports everything was "straightforward and easy."

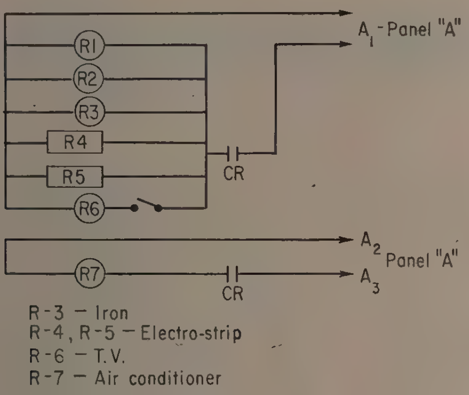
Other Electrical Features

Outdoor lighting comprised most of the other electrical features of the project. Two 30-ft standards, each with four 400-watt mercury-vapor luminaires, illuminate the parking area. Inverted twin aluminum lampholders with R30 75-watt bulbs highlight the underside of the unique zig-zag roof overhang. In addition, each unit has an illuminated room number.

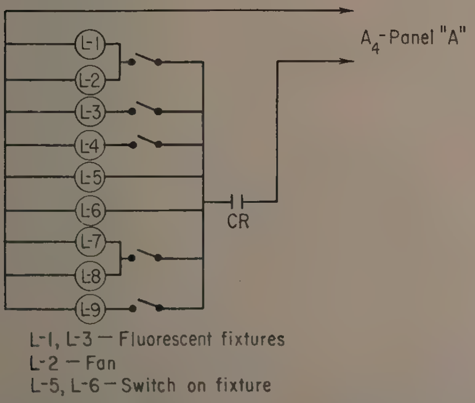
The swimming pool has underwater lighting. There are two insect electrocuters, one near the pool and one at the river's edge patio near the restaurant. Electric heating was also installed in the entrance area of the restaurant.

Because the existing restaurant has gas heating and cooking, gas was used to heat water for the 35,000-gal pool, bath water and for laundry appliances. Cunningham has commercial equipment to handle the restaurant and motel linen as well as uniforms.

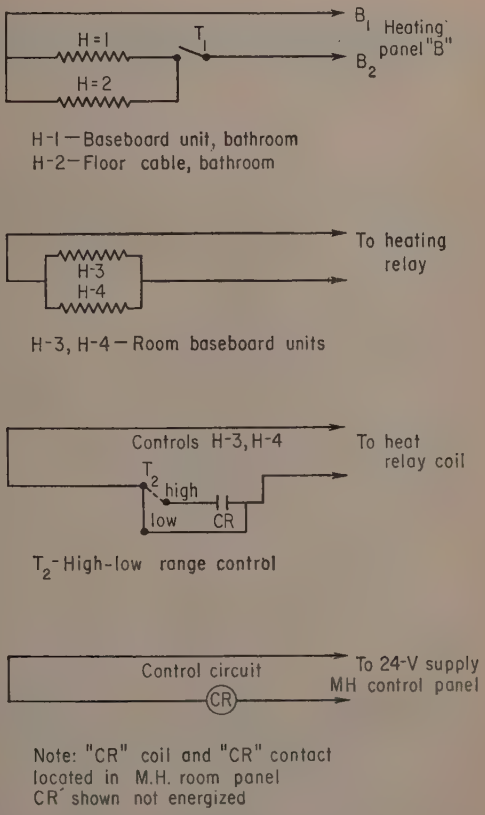
Plans for the 24-unit addition will be all-electric too. Electrical features will duplicate those of the present motel. Feeders and circuits will be carried under the highway to the existing service equipment. The future units will be electrically controlled from the master panel in the existing motel office.



RECEPTACLE CIRCUITS



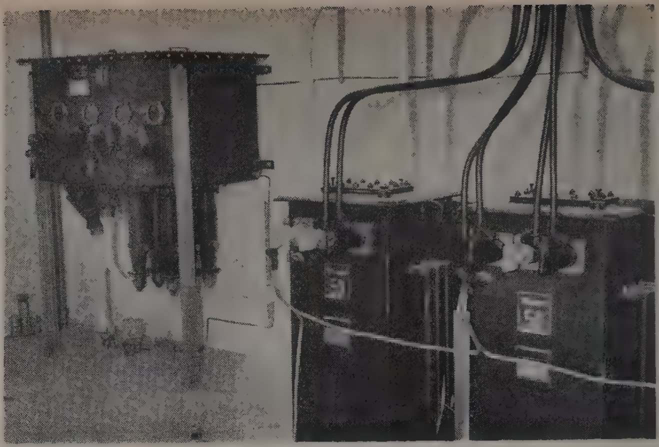
LIGHTING CIRCUITS


H=1
H=2
T_1
B_1
B_2
Heating panel "B"
H-1 — Baseboard unit, bathroom
H-2 — Floor cable, bathroom
H-3
H-4
To heating relay
H-3, H-4 — Room baseboard units
Controls H-3, H-4
T_2
high
low
CR
To heat relay coil
T_2 - High-low range control
Control circuit
CR
To 24-V supply MH control panel
Note: "CR" coil and "CR" contact located in M.H. room panel
CR shown not energized

ELECTRIC HEATING CIRCUITS

CIRCUIT DETAILS for receptacles, lighting and electric heating in typical motel unit. Letter and numeral identifications refer to corresponding symbols on room layout plan.

MAIN 12-KV SWITCHING STATION for new San Diego marine terminal is pad-mounted weatherproof installation containing 250-mva 1200-amp air circuit breakers related to two underground shielded feeders; either one of which can serve any or all 13 local transformers in this flexible distribution system.



TYPICAL UNDERGROUND VAULT shows one of 26 15-kv 400-amp load-break oil switches (at left) equipped with stud-bushing compartments (below) that permit connection of additional cables without taking switches out of service. Group of 50-kva single-phase transformers (at right) are equipped with emergency overload features and current-limiting breakers that protect primary circuiting and transformer windings alike.

Port of San Diego's growth dictated creation of unique . . .

12-KV Underground

Twin shielded feeders plus 26 submersible load-break switches having multiple contacts and stud bushings permit: 1) System to be used either as loop or radial installation: 2) any substation transformer to be isolated or served by either feeder, and 3) system to be expanded without interruption of service. Installation was by Standard Electric Contracting, Inc., of Chula Vista, Calif.

By **Willis L. Lipscomb**, *Consulting Electrical Engineer*

KEEPING abreast of shipping requirements at the Port of San Diego is a tough problem, for the lusty growth of this, the west-coast's third-largest marine center, is dictating the steady addition of new docking, cargo-handling and storage facilities. And, since present growth trends show little inclination to diminish, Port authorities have wisely subscribed to a long-range expansion and modernization plan which was recently inaugurated by creation of a new Tenth Avenue Terminal.

Already rated by international shipping analysts as being among the world's most modern marine terminals, this new 90-acre facility includes a half-mile-long quay where nine ocean-going freighters can load or unload simultaneously; each of these nine positions being equipped with motorized oil-bunkering equipment plus quay-side "mounds" to provide ships with shore power and telephone service.

Plans also call for two gantry cranes powered by 800-hp motors; 10 acres of transit sheds; 17 acres for warehousing cargo awaiting transfer to or from ships, trucks or trains; modern illumination that includes street, protective and functional lighting equipped with automatic as well as manual controls; electric cathodic protection for steel piling in the quay wall; extensive intercom, telephone and fire-alarm systems, with master alarm boxes mounted conveniently on exteriors of all buildings, lighting towers and poles, and with red lights mounted above boxes to plainly identify the calling station in event of an emergency.

Translated electrically, this development emphasizes the need for dependable power. And, as a key component in this demand, a 12-

SERVICE STATION switches and plug facilities, located in nine quayside "mounds," provide moored ship-going freighters with shore-based power (left) and telephone facilities (right). Holes in reinforced-concrete protective structures permit connecting cables to be extended between ship and shore terminal plugs. Mounds are energized through underground feeders radiating from local transformers vaults which, in turn, are served through simulated loop system discussed in this article.

LENSED FLUORESCENT LUMINAIRES are mounted above transit shed and warehouse doors for local illumination, while pole-mounted mercury-vapor units provide general illumination along half-mile-long quay. This new 90-acre terminal is also equipped with intercom, telephone and fire alarm systems; master alarm boxes for the latter, with identifying red signal lights above them, being mounted on building exteriors and free-standing lighting poles.

Loop for Marine Center

kv underground distribution system has been installed which should provide adequate service for some years to come. Should present growth accelerate, however, switchgear now installed could readily be incorporated into an expanded system capable of also serving a second, adjacently-located terminal which would be equal in size to the facility just completed.

This distribution system combines dependability with flexibility, for two 12-kv duct-contained feeders extend from the main switchboard in such a manner that they can be operated either independently, with each feeder serving half of the load-centers on the terminal site, or (by adjusting oil switches located variously in manholes and vaults), either feeder could be used to carry power to all of the transformer substations.

While normal procedure is to use the two feeders as separate radial runs, switching provisions can effectively simulate loop conditions whereby any given section of either feeder could be isolated should a fault condition develop. With this provision, any power outage of long duration would be unlikely.

Each 12-kv, 3-phase, 3-wire feeder is energized through a 250-mva, 13.8-kv, 1200-amp air circuit breaker provided with relay overcurrent protection, while approximately 12,000 ft of 15-kv, 3-conductor, 19-strand, shielded copper cable (paper insulated, lead covered, neoprene jacketed) was used to form this basic distribution system having a 4200-kva capacity with a load factor of 75%.

All load-break switches are submersible, each being rated for 400 amps at 15-kv, and each being provided with multiple switching contacts so that any transformer in the system can be either completely isolated, or connected to either one of the two underground feeders. In the complete installation, a total of 26 such switches is used; one of two types being a 3-way unit serving the function of three separate switches (1- loop-through, 2- isolating, and 3- double-throw), while the second type is a 4-way unit that permits combinations of loads and feeders to be established through various arrangements of load-break disconnects. It is also pertinent to mention that stud-bushing compartments are provided on all switching assemblies so that the system can be expanded without interrupting service to substations.

These various features of flexibility, dependability, safety and ease of expansion constitute a system of unique design. And, equally important, the dollar investment in this system appears to be no greater than that expended to provide lesser benefits to similar marine projects located in other ports. Finally, it may be stated that shipping interests and San Diego harbor authorities concur that the installation fully achieves all initially-established objectives.

Terminal facilities were planned by Harbor Engineer Joachim E. Liebmann; with Willis L. Lipscomb, Consulting E. E., designing the electrical system which was installed by Standard Electric Contracting, Inc., of Chula Vista.

How to Prolong the Life of Motors

Simple maintenance checks can cut motor burnouts and costly repairs. An overheated motor indicates a short life expectancy, and the author describes possible causes and remedies where overheating is detected.

By **J. L. Watts**, *A.M.I.E.E., Southampton, England*

WHEN an electric motor is turned on, heat generates internally because of various losses. As a result its temperature rises gradually. When its temperature rises, heat dissipates from the motor at an increasing rate by radiation, convection air currents, and usually by air which is blown over the windings or motor case. Under constant load the motor eventually reaches a constant temperature, where the rate of heat dissipation equals the rate of heat accumulation (Fig. 1). Constant temperature occurs more rapidly with a highly ventilated high-speed motor than with an enclosed or slow-speed motor. Other things being equal, the losses and heat generation in a motor of a given horsepower depend on its efficiency. Machines are designed so that, if used under normal conditions with rated load, the motor temperature will be limited. And there will be no undue deterioration of its insulating materials.

Motor Life and Temperature

The normal life of a motor depends very largely on the temperature at which it is allowed to operate. And the permissible temperature depends on the class of insulating materials used in its construction. Fig. 2 gives an indication of the possible life of motors at different temperatures. To prolong motor life, operating conditions should be controlled so as to limit the motor temperature. Any indication of overheating should be quickly detected in order that the cause can be diagnosed and rectified before damage occurs.

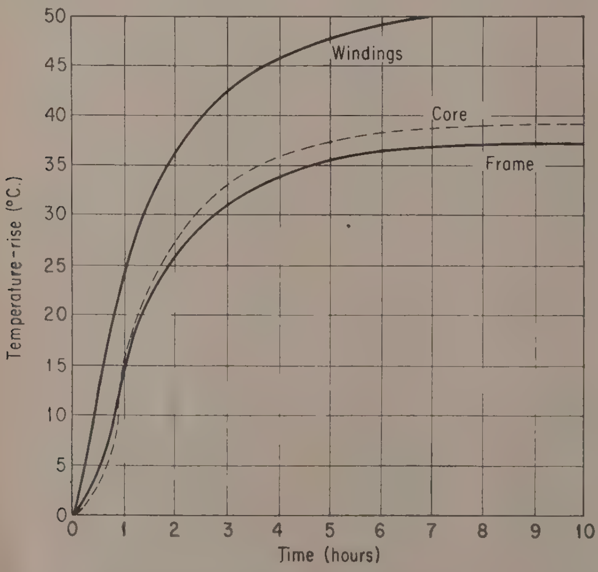


FIG. 1—TEMPERATURE-RISE TIME CURVES are for a small enclosed ac motor. Under constant load a motor eventually reaches a constant temperature, where the rate of heat dissipation equals the rate of heat accumulation.

Insulating materials used in electric motors are listed in certain classes. And the class of insulation is usually marked on the motor nameplate or stated in the maker's literature. Class A insulations consist of organic materials such as cotton, silk or paper. They are impregnated with a liquid dielectric such as varnish or enamel, and are designed to operate at a maximum temperature of 105 C. Class E materials have a maximum designed operating temperature of 120 C. For Class B materials (mica, fiberglass or asbestos) held together with an inorganic binder, the maximum designed temperature is 130 C. For Class F materials, up to 155 C temperatures are tolerable. Class H insulation consists of inorganic materials, which include silicone elastomer and combinations of materials such as fiberglass, asbestos, or mica. They are held together with silicone resins. Class H insulation has a maximum permissible temperature of 180 C.

Temperature Measurements

If possible, a periodical check of the temperature of each motor should be made. If the motor appears hot when tested by hand, and there is no readily apparent cause, it is advisable to measure the temperature accurately. Where the windings and/or winding cores are accessible, a mercury thermometer

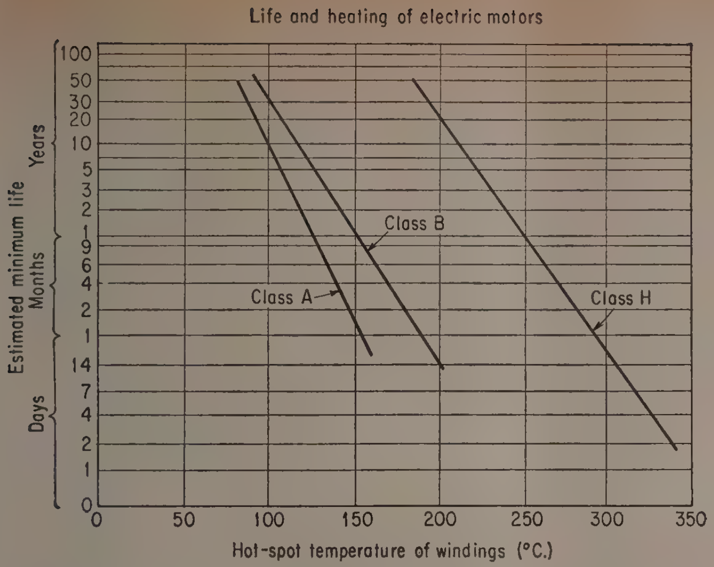


FIG. 2—ESTIMATED LIFE EXPECTANCY of Class A, B and H motor winding insulations is shown in the chart at different winding temperatures. To extend motor life, operating conditions should be controlled so as to limit the motor temperature.

may be used. The thermometer bulb should rest on the hottest external surface of the windings or the iron cores with which the windings are in contact. For correct results, parts of the bulb that do not contact the tested surface should be well covered by a pad of felt, cotton, wool, or other non-conducting material.

It is important to note that the hottest spot will be in the interior of the windings, which cannot be reached by a thermometer. For a reasonable motor life the temperature of any accessible part of the winding, or of the core in contact with the winding (as measured by the thermometer), should not exceed the ambient temperature plus the value given in Column 3 of Table 1. If the ambient temperature exceeds 40 C, the permissible temperature-rise should be correspondingly reduced.

In some cases a motor contains embedded temperature detectors, thermocouples, or resistance thermometers. If the motor life is not to be shortened considerably, the temperature indicated by any such device should not exceed the ambient temperature plus the value given in Column 4 of Table 1. Again the permissible temperature rise should be reduced proportionately when the ambient temperature exceeds 40 C.

Another method of calculating the average temperature of the windings is by measuring the increase of resistance of the heated windings. This involves very accurate measurements by passing direct current through the windings. The cold resistance (R_c) of the windings should first be measured when the machine is at the temperature (T_c C) of the surrounding atmosphere. In a large machine this may involve measuring this resistance after the machine has been standing for 24 hrs or even longer. After running the machine normally the hot resistance (R_h) of the windings should be quickly measured again immediately after the motor has been shut down. The temperature T_h C of the hot windings then equals R_h/R_c $(T_c + 234.5) - 234.5$. Again, the maximum permissible temperature should not exceed the ambient temperature plus the value given in Column 4 of Table 7, with reduced temperature-rise if the ambient temperature exceeds 40 C.

Faulty Ventilation

Inefficient ventilation is a common cause of motor overheating even when rated voltage and current are correctly applied. This may be due to an accumulation of foreign matter in the air duct of a pipe-ventilated motor or on the case, ventilating screens or windings of other types of motors. In dirty locations, totally enclosed fan-cooled motors or pipe-ventilated motors are desirable. Even then, overheating may occur from installing the motor in a confined space or in a hot-air pocket, which is closed at the top. Adequate ventilators are needed in such locations.

On the other hand a motor can overheat on normal load if the ambient air temperature is too high. If necessary, the motor should be shielded from a nearby source of heat to avoid heating by radiation from the hot source. And it should be ventilated by air drawn from a cool source. It is often possible to drive machines in a hot room through an extended shaft from a motor in a cooler location.

A possible solution to the problem of using a motor in a hot position is to use one of greater horsepower than the load requires. While the motor will take its normal magnetizing current, the load component of the motor current will then be less than normal, thus limiting the

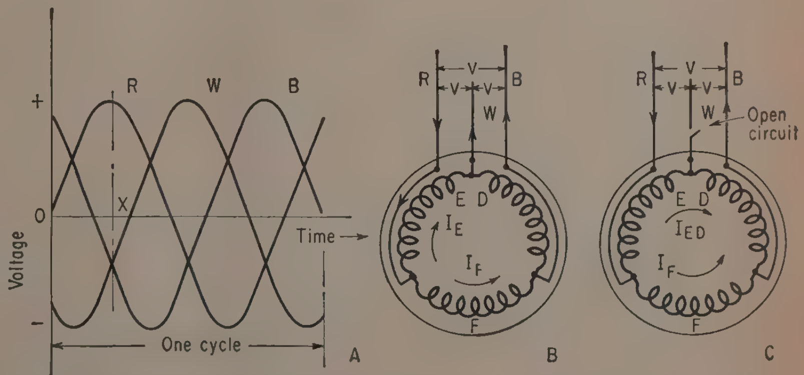


FIG. 3—DISTRIBUTION OF CURRENT in delta-connected stator windings is affected by an open circuit in one leg of a 3-phase circuit. A shows the current flow at the instant X in the ac cycle. B shows current flow under normal circuit conditions, and C shows the current flow with one phase open.

Class of insulating material.	Maximum permissible "hot-spot" temperature.	Maximum permissible temperature rise of windings or core measured by thermometer.	Maximum permissible temperature rise by rise-of-resistance method or embedded temperature detector.
A	105°C.	55°C.	60°C.
E	120°C.	65°C.	70°C.
B	130°C.	75°C.	80°C.
F	155°C.	95°C.	105°C.
H	180°C.	115°C.	125°C.

TABLE 1—MOTOR WINDING INSULATIONS are rated in various classes. The maximum operating temperature limits for Class A, B, E, F and H insulations are given in the table.

Motor loading expressed as a percentage of rated full-load current.	Percentage of full-load current in the two sound lines R and B with third line W open-circuited.	Percentage of full-load current in phases D and E of motor windings with third line W open-circuited.	Percentage of full-load current in phase F of motor windings with third line W open-circuited.
40	58	35	83
45	67	40	95
50	78	46	106
55	89	53	118
60	102	60	132
65	116	68	145
70	132	75	160
75	147	85	176
80	165	95	194
85	183	104	212
90	200	115	232
95	222	125	257
100	242	136	280

TABLE 2—CURRENT DISTRIBUTION in a 3-phase, delta-connected induction motor will vary according to the motor loading when one phase opens. Phase markings in the table refer to those shown in Fig 3.

rate of heating of the conductors and the temperature rise of the motor, to keep the hot-spot temperature within bounds. However, the motor will have a lower efficiency and power factor than normal. If this method has to be adopted the use of a motor having insulation which is capable of high-temperature operation will limit the physical size of motor required.

Overheating may occur in some parts of the motor windings if the voltages between phases at the motor terminals are unequal, in which case the currents to each line terminal of the motor and starter also will not be equal. The cause may be a fault on the supply to the premises, unbalanced single-phase loads on the installation, or a high resistance in one line as might result from a loose connection, faulty contact or the like. A similar effect may be experienced if there is an open circuit in one supply line that feeds the motor in question and also feeds one or more other motors, which are in operation.

If an open circuit occurs in one of the lines to one motor only, the motor will not be self starting when switched on at rest. If the open circuit occurs when the motor is running the current in two lines will increase, the current in the open-circuited line will fall to zero, and the voltages on the motor side of the break will be somewhat unequal. Fig. 3 shows how the distribution of current in delta-connected stator windings is affected by such an open circuit. Fig. 3b shows the current flow at the instant X in the ac cycle shown in Fig. 3a under normal conditions; while Fig. 3c shows the distribution when running with an open-circuited line W.

Table 2 shows the currents in various parts of the delta-connected stator windings on various loads. It will be noted that one phase F may become seriously overloaded without the current in the other two lines reaching the operating value of an overload release. Thus the motor may be left overheating on load.

An open circuit may be due to a melted fuse, faulty contact, loose or broken connection, or a burned conductor. It is important that all connections be kept clean and tight, spring washers or locknuts being used to secure all screwed or bolted connections that are subject to vibration. The fuses in each pole protecting a 3-phase motor must be the same size. Otherwise, one small fuse might melt, possibly during starting, and leave the motor single-phasing through the other two (larger) fuses. Expensive motors, and motors used on lines where an open circuit is likely, can be given special protection against this risk by a protective device, which operates on unequal line currents as well as excessive current.

Electrical Faults

Unequal currents to a motor, with equal voltages of normal value between the phases, may indicate a fault in the motor circuit such as an open circuit, short circuit or a ground. If resistance measurements between pairs of stator terminals give unequal readings, the cause may be an open circuit or a short circuit. The former fault may result in overheating of the sound part of the windings, while a short circuit causes rapid burning, smoking, embrittlement or discoloration of the short-circuited windings. A ground may cause overheating of part of the motor. It may be detected by using an insulation-resistance test set, or by applying a suitable supply through a test lamp between the motor terminals and case.

Table 3 sums up various causes of overheating, together with the indications of the various possible defects. Removal of such causes of overheating as soon as possible may considerably prolong the life of a motor, as well as avoid direct and consequential expenses, which might be involved should a breakdown occur.

Still another cause of motor overheating is excessive current in some or all parts of the windings. The rate of heat generation in conductors is proportional to I^2. Thus 10% excess current causes heat generation at 21% above the designed rate. To measure the current in each supply line to the starter of a hot motor, use a "clamp on" ammeter. The subsequent readings should be compared with the full-load current marked on the motor or as given in Table 430-150 of the 1959 NEC. The full-load current of a motor of a given horsepower is inversely proportional to the rated voltage. It may also be advisable to measure the voltage between each pair of motor terminals.

If there are equal but excessive currents in each supply line, and voltages are normal and equal at the motor, mechanical overload should be suspected. On the other hand, there may be too many machines driven by the motor. The driven machine may be out of adjustment, incorrectly used, driven at too high a speed or fed at too high a rate; or cutting tools may be dull. Belts may be too tight, a direct-coupled motor may be out of line, or the lubrication may be faulty. There may be an overload in the motor itself due to a partly seized bearing, or a worn bearing causing the rotor to rub on the stator. Each motor should be protected by properly sized motor running protective devices, which will trip the starter in the event of any serious overload.

If the voltage at the motor terminals is below normal the motor will take an excessive current to develop its rated horsepower. The voltage rating of the motor may be too high, the supply may be at fault, or it may be desirable to use tappings of higher voltage on the supply transformer. There may be an excessive voltage drop on the cables feeding the motor, due to these being too small. The latter cause may be suspected if the voltage at the motor terminals on load is much below the voltage at the supply terminals with the motor switches off.

If the voltage at the motor terminals is too high, the motor will take more than its rated current to develop its rated horsepower. If the motor is designed for a fairly high magnetic flux density in its cores, it will then take a high magnetizing current and may overheat even on light load. The voltage rating of the motor may be too low, or the taps on the supply transformer may not be set correctly.

If a motor is designed to run with delta-connected stator windings and is run with them connected in star instead, each phase of the windings will operate on 58% of the line voltage only, instead of the full line voltage. Each phase will then carry the full line current instead of 0.58 of the line current. And the motor will overheat on load with no more than rated line current.

Most motors take much more than their rated full-load current during starting and may, therefore, overheat if the starting period is unduly prolonged due to starting against a high-torque load or starting a load of greater-than-normal inertia.

In conclusion, when a motor runs hot, quickly determine and correct the cause. This will eliminate costly shutdowns and repairs, prolong life, and greatly improve machine efficiency.

Symptoms	Currents	Voltages	Possible causes
Overheating on load.	Normal & equal line currents to starter.	Normal, & equal between phases.	Prolonged starting periods. Excessive frequency of starting. Excessive or too frequent running of short-time rated motor. Faulty ventilation.
"	Equal but excessive line currents to starter.	Normal, & equal between phases.	Mechanical overload. Motor rated for too high a voltage.
"	"	Low and equal at motor.	Supply fault. Incorrect transformer tappings. Cables too small.
"	Normal & equal line currents to starter.	Line voltages at starter equal & normal.	Starting operation not completed.
"	Normal & equal line currents to starter. Excessive & equal currents in stator windings.	Line voltages at starter equal and normal. Low & equal voltages at stator windings.	Motor run in star instead of delta. Dual-voltage motor run on the lower voltage with series-connected stator windings.
"	Unequal line currents to starter.	Unequal line voltages at motor.	Supply fault. Unbalanced single-phase loads. High-resistance connection or contact. Open circuit in one supply line to a distributing point.
"	Zero current in one 3-phase motor line.	Normal & equal at distribution point.	Open circuit in one phase of a 3-phase motor circuit, or in one phase of star-connected motor windings.
"	Equal in two lines. Increased current in third line.	Normal.	Open circuit in one phase of delta-connected stator windings.
Overheating even on reduced load.	Line currents equal but excessive.	Normal and equal.	Motor rated for too low a voltage.
"	"	Equal but excessive.	Supply fault. Incorrect transformer tappings.
"	"	Equal and normal line voltages at starter. Equal & high at sections of stator windings.	Motor run in delta instead of star. Dual-voltage motor run on the higher voltage with parallel-connected stator windings.
Overheating on all loads.	Line currents somewhat unequal.	Equal and normal.	Short circuit or ground in motor.

TABLE 3—VARIOUS CAUSES OF OVERHEATING in motors, together with the indications of the various possible defects, are given in the table. Possible causes of overheating are based on abnormal current and voltage characteristics.

Hospital Installs 150-Kw Standby Plant

Large capacity power plant for dependable emergency supply was financed in conjunction with the Civilian Defense Program.

A DEPENDABLE emergency power plant is absolutely essential in the operation of a modern hospital because everything from operating room lighting systems to boiler room controls—from kitchen equipment to X-ray machines—are dependent on an uninterrupted supply of electricity. A power outage of any duration could seriously jeopardize patient welfare. For these reasons, All Souls Hospital, Morristown, New Jersey, recently installed an ONAN 150-kw standby plant. This emergency plant will guarantee that all vital facilities can carry on when normal power service fails. Installation of this plant was made as part of a $3,000,000 addition to the hospital.

In the past, the hospital had to depend on emergency battery lighting in operating rooms and gas jet emergency lighting on stairways during power outages. At such times all other services virtually came to a standstill. In the severe ice storm of 1948, for example, when power lines were down for three days, the hospital was in a very precarious position. But the hospital has now invested approximately $37,000.00 in an emergency power plant, with the help of the Civilian Defense Program, which pays 50% of the cost.

The big, diesel-powered 150-kw plant, which is a water-cooled unit generating 120/208-volt, 60-cycle, 3-phase current, is located with the automatic transfer switch and the disconnect panels in a concrete-block room adjacent to the boiler room in the newly constructed service building. Because the complete emergency unit is mounted on a concrete floor, the floor bolts pass through composition pads that effectively absorb vibration when the unit is operating. The exhaust from the diesel is carried by pipeline into the main boiler room stack.

When the generator is started up by a real emergency, it is necessary to switch the various lines in gradually, up to the capacity of the standby plant. Therefore the location of the plant had to be near the power plant engineer's station, where there is always a man on duty. The 1500-gallon diesel oil tank, which has capacity to operate the generator for three days, is located just outside the service building, opposite the wall where the standby plant is housed.

Describing the various hospital services that would be served by the standby plant, John Glaab, chief engineer of the hospital says: "Because the operating rooms in the main hospital building and the maternity building are located on the top floors, it is most important that one elevator in each building be kept in operation. The main building elevator requires 70 kw; and the maternity building elevator, 15 kw. The boilers (2, plus controls) require 12 kw; two feed pumps, 20 kw; vacuum pumps, 3 kw; refrigeration units, 5 kw; fire alarm system, 2 kw; public address system, 1 kw; stairways and exits, 6 kw; emergency room, 2 kw;

TRANSFER SWITCH adjacent to emergency generator in the new service building provides for automatic starting of the diesel unit and transfer of the essential load feeder from normal supply to the emergency generator—when normal power fails.

DIESEL-DRIVEN emergency power plant is rated at 150 kw, 120/208 volts, three-phase, 4-wire, to meet the heavy and varied power demands of hospital electrical equipment during outages of normal electrical supply to the premises. Oil supply tank is just outside the building wall.

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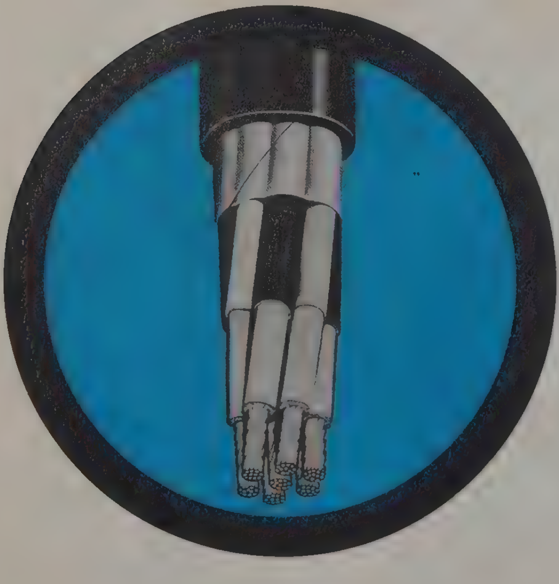

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If you can find any Romans around, ask them. They lived pretty high on the hog in their day. That is, until some serious-minded neighbors from up North moved in. The rest is ancient history.

You'd think their fate would have taught us a lesson.

Yet today we Americans spend twenty billion dollars a year for legalized gambling, while we spend a niggardly four-and-a-half billion for higher education. Think of it! Over four times as much! We also spend six-and-a-half billion dollars a year for tobacco, nine billion dollars for alcoholic beverages, and billions more on other non-essentials.

Can't we read the handwriting on the wall?

Our very survival depends on the ability of our colleges and universities to continue to turn out thinking men and women. Yet today many of these fine institutions are hard put to make ends meet. Faculty salaries, generally, are so low that qualified teachers are leaving the campus in alarming numbers for better-paying jobs elsewhere.

In the face of this frightening trend, experts estimate that by 1970 college applications will have doubled.

If we are to keep our place among the leading nations of the world, we must do something about this grim situation before it is too late. The tuition usually paid by a college student covers less than half the actual cost of his education. The balance must somehow be made up by the institution. To meet this deficit even the most heavily endowed colleges and universities have to depend upon the generosity of alumni and public spirited citizens. In other words, they depend upon *you.*

For the sake of our country and our children, won't you do your part? Support the college of your choice *today.* Help it to prepare to meet the challenge of tomorrow. The rewards will be greater than you think.

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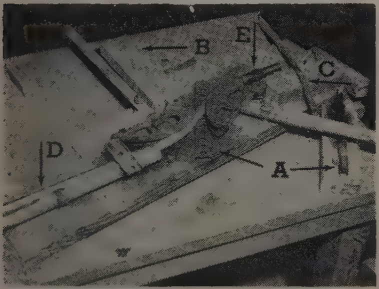
and operating room lighting system, 5 kw. By removing the fan from the standby plant, and substituting a watercooled system, we will be able to increase the output of the generator to 180 kw and thereby be able to take care of all possible emergency power demands.

"One of the factors that influenced the selection of this standby plant by our electrical contractors, the E. J. Stewart Electrical Contracting Company, Morristown, New Jersey, is the fact that the complete unit is easily transportable to another location on its base frame, which is also one of the conditions for Civilian Defense participation in its cost. We will, of course, run the diesel for a half hour once a week, to insure its proper operation if actually cut in by the automatic transfer system. The transfer control automatically starts up the diesel unit if voltage on normal service drops below a predetermined point or if there is a complete outage of the high lines to the hospital."

Jigs and Pre-Fab Methods Are Large-Job "Naturals"

One of San Francisco's newest skyscrapers, the 20-floor Crown-Zellerbach building, provides duplicate lighting, air conditioning, power receptacle, communications and telephone facilities for each 5½-by-5½-ft module on 16 "typical" office floors. And, since there are



TWO PIVOTED HICKEYS were positioned tangentially in order to put reverse bends in thinwall conduit sections. Metal base plates (A) insure bending action taking place in same plane; terminal blocks (B) insure hickey handles being pulled to same limits; spring (C) automatically snaps hickey bar back to the "ready" position after each bend has been completed; long pressure bar in left foreground (D) keeps main stem of conduit straight, while terminal socket on other hickey (E) keeps far end of conduit exactly positioned and free of deformation during process.

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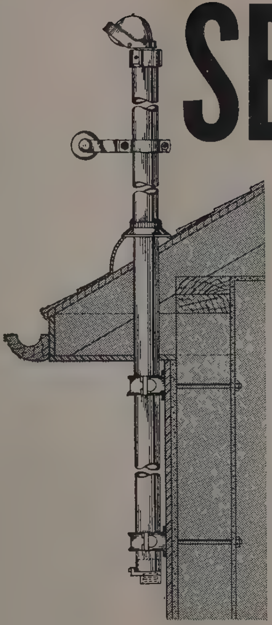

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THINWALL CONDUITS, pre-cut to exact lengths and reamed to remove burrs prior to bending operation, are temporarily stored above workbench until a "batch" has been completed. Sections are then bundled to await transfer to job-sites on upper floors.

approximately 7000 such modules in the total installation, an excellent opportunity was afforded whereby repeatedly-duplicated system components could be pre-fabricated and mass-assembled to simplify subsequent installation routines. In these various preliminary processes, several practical methods were designed on the job-site to insure exact duplication.

For example, after thinwall conduits had been cut to desired lengths by a motorized hack-saw, they were given a series of reverse bends so that junction boxes (related to the lighting installation) could be offset in accordance with local mounting requirements.

To make these reverse bends quickly and accurately, Chick Terrill, job superintendent for contractor Charles A. Langlais, devise a special jig consisting of two pivoted hickeys; one of which wa fitted with a terminal socket to exactly position and hold end of the conduit. Since this socket wa equipped with a solid interior hu which slipped snugly inside the en of the conduit, the tubes are no flattened during bending process.

The second hickey was equippe with a long pressure bar (bolted t one end of the hickey head-groove that prevented the conduit fro being deformed except at the desired offset point.

As noted in an accompanyin photo, a section of perforated scra iron was positioned between the tw hickeys to provide a firm slidin surface for the thinwall tubing blocks of wood were secured to th bench-top so that hickey handle could be rotated only within exactly

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FIXTURE WIRES consisting of a pair of No. 16 AF conductors are pulled through flexible fixture connections in single operation, since the two wire reels are mounted on common shaft (left foreground) and, after skinning, the two ends are temporarily held together by a small wire nut that slips easily through the flex.

TOMIC COLLARS are inserted into ends of flex with use of special hand tool that spins twin lugs of collar down into voids of spiral casing. Use of these smooth-lipped snugly-fitting collars eliminated necessity for using additional fiber inserts or attachment screws.

prescribed limits; adjustable-height metal channel sections were placed beneath hickey handles to insure the two reverse bends being formed in the same plane, and springs were attached to hickey handles to automatically pull them back to their original starting points when pressure was released upon completion of this bending operation.

As conduits were successively bent into their desired forms, they were temporarily stored on a conveniently-placed overhead rack.

Since the huge lighting system also contains 7000 6-ft-long flexible metal conduit sections (connecting individual luminaires with related JBs), it was likewise possible to pre-cut these lengths, then equip the ends with Tomic collar inserts which (when screwed firmly into position) eliminated the necessity of using additional fiber inserts.

With twin lugs of collars engag-

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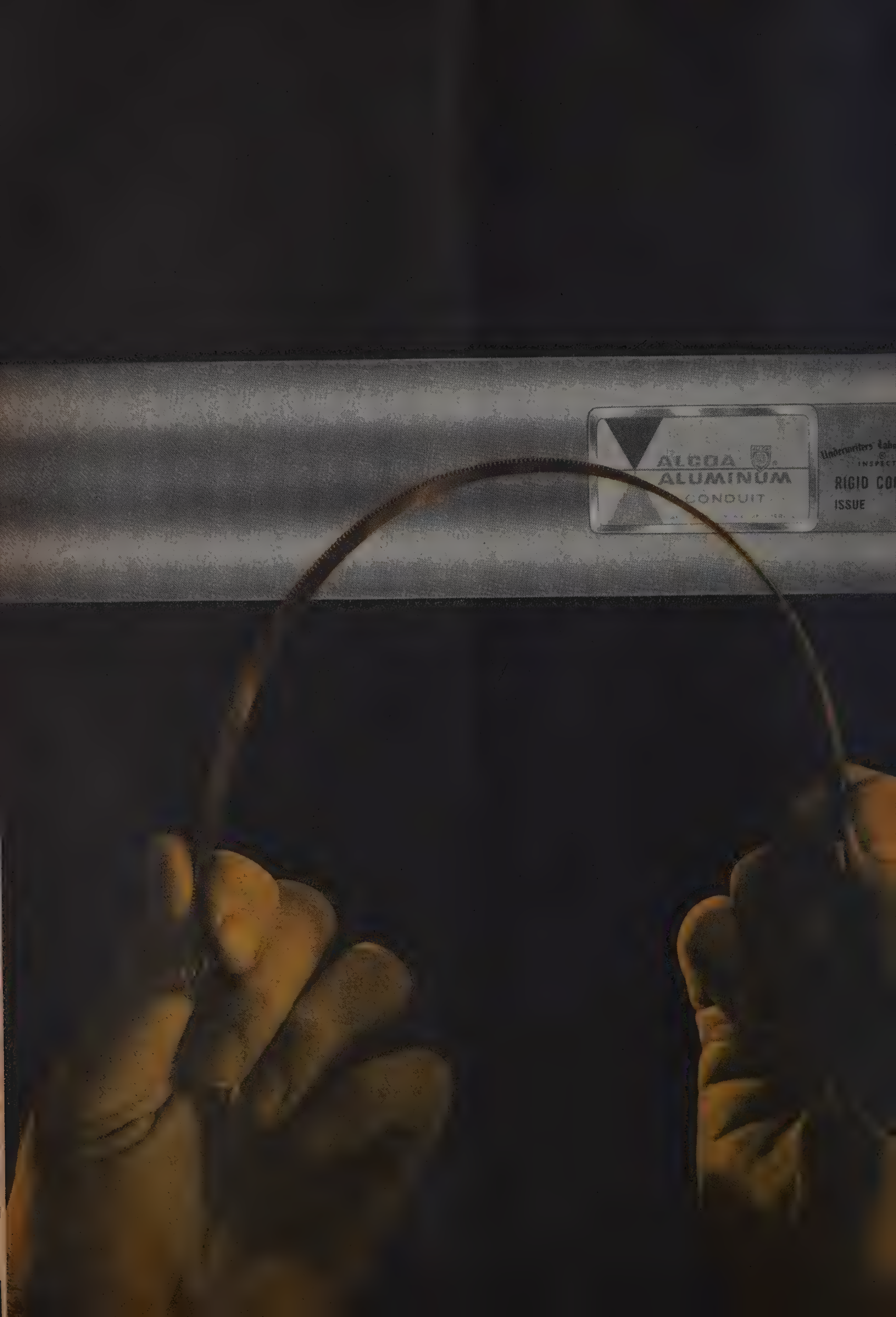
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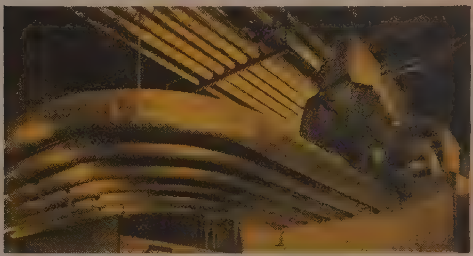
If you would like free literature spelling out the many advantages of Alcoa aluminum conduit, write to Rome Cable Division of Alcoa, Dept 7-80, Rome, New York.



Save on installation costs by taking advantage of Alcoa aluminum conduit's light weight for ease of handling and erection.

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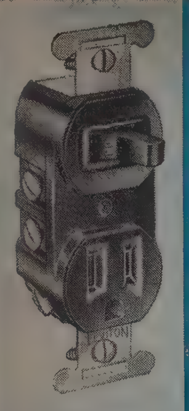

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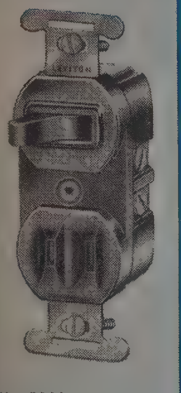

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RUGGED CONSTRUCTION! Base molded of brown phenolic... covers of either brown phenolic or ivory thermosetting plastic. Heavy gauge rustproofed underslung steel strap is riveted through cover and body to form a permanent assembly.

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Rating Quiet Switch: 15A—120V AC only	Rating Quiet Switch: 15A—120V AC only	Rating Quiet Switches: 15A—120-277V AC only	Rating Quiet Switch: 15A—120V AC only
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AT UPPER-FLOOR JOB-SITE, pre-cut, pre-wire conduits and flexible fixture connections are attached to deep junction boxes by double locknuts and bushings placed both inside and outside knockout openings. These pre-fab mass-assembly methods greatly simplified assignment of accurately installing 7000 luminaries in 20-floor San Francisco skyscraper.

ing the spiral casing of the flex, the collars could be twisted down into place quickly with the use of a special handle-equipped hand-saving tool designed for that purpose. And, with collar lugs in such intimate contact with casing grooves, additional set-screws for fastening collars were unnecessary.

After collars were secured in place, fixture wires (a pair of No. 14 AF conductors) were end-skinned, temporarily twinned together by means of a capping wire nut, then easily pushed through the flexible lengths. As noted in another photo, the two reels holding the pair of wires were mounted on a common horizontal spindle (cradled by a box frame located at one end of the work-bench); this method permitted the two wires to be pulled simultaneously in a single operation, then cut and again end-skinned at exactly corresponding lengths.

After these bent-conduit and prewired flexible fixture connections had been thus prepared, they were bundled, hoisted up the outside of the building by a roof-mounted motorized winch, and then pulled through an open window-wall when they had reached their intended floor.

There they were attached to deep outlet boxes, secured by locknuts placed inside box knockouts, and were then installed in position atop the suspended ceiling channel grid.

Since air-conditioning ducts (previously installed) had supply vents placed alongside each fixture opening, the loose ends of the flexible connections were temporarily tucked inside these vents to keep them clean and out-of-the-way until final fixture connections were made.

World Headquarters offices of Pepsi-Cola Company, 500 Park Avenue, New York City, are illuminated with ceiling panels of new impact resistant rigid vinyl sheet panels of modular design. Illumination level is 50 foot-candles at desk height. The Bakelite vinyl panels were fabricated by Piolite Plastics Corp. Lighting was by Globe Lighting Products, Inc., and installation by Fischbach and Moore, Incorporated.

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Bakelite rigid vinyl sheet forms panels with extra resistance to hard knocks and rough handling during installation and maintenance . . . they are resistant to warping and cracking . . . they go years without discoloration by ultraviolet. Costs can be cut because much thinner sheets can be used than for other types of diffusers. They're self-extinguishing, and in addition the installation can be designed so they'll soften and fall out before the sprinkler operating temperature.

With new Bakelite high-impact vinyl sheet you get greater freedom of design...new beauty for older fixtures . . . much longer service life.

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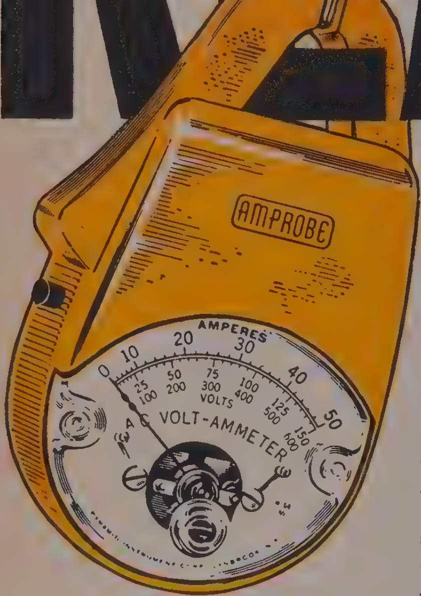

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and amperage
in a snap!

A voltage "indication" doesn't give you all the information you need to do a job right. You want a precise voltage *reading*, measured on a calibrated scale... and you get it with the AMPROBE JR. But sometimes voltage is only half the story. Most jobs require an accurate *current* reading too. The pocket-size AMPROBE JR. provides it – in a snap – *without* interrupting service! Why settle for anything less?

*SPECIAL OFFER

Trade up to an AMPROBE JR. *now*. For a limited time only, we'll give you a sturdy leather case plus the AMPROBE ENERGIZER (to multiply the JR.'s sensitivity *ten times*)—an *$8 value*—for *only $1* and your obsolete voltage tester! The leads come with the JR. Snap up this offer today—at your distributor.

Amprobe Jr.
snap-around volt-amp tester
$19.85

PYRAMID INSTRUMENT CORPORATION, LYNBROOK, NEW YORK
Serving the Electrical Testing Needs of Industry

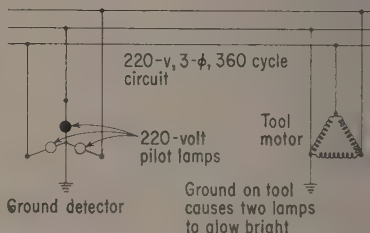
Reference to air conditioning vents calls for one added commen concerning practical design considerations; for, to promote ventilation through fixture housings an therefore lower ambient temperature within the enclosures, lighting fixtures were equipped with air duct connections at one end an with louvered grilles at the othe for the return of circulated air t the overhead plenum chamber.

Since fixtures could be installe (or removed) by simply turnin wing-nuts on channel-mounted bolts and since lighting JBs wer mounted just above and to the sid of fixture openings, easy access wa provided for the subsequent addition of low-voltage transformer and relays, should specific tenant desire local 24-volt switching i addition to the standard panel-controlled 265-volt breaker arrangement.

Ground Detector For High-Cycle Circuits

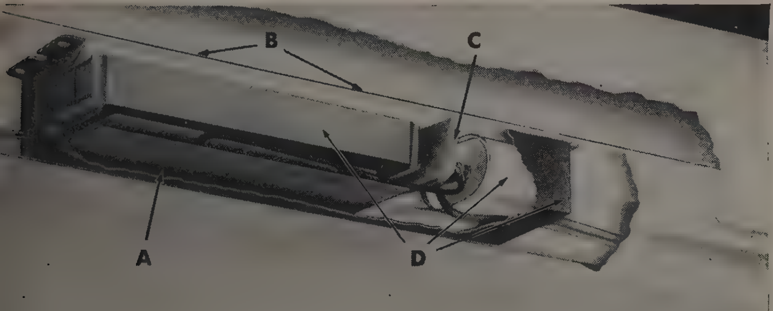
High-cycle grinders and sander are used in the metal-finishing department of a midwest industria plant. Occasionally one or mor tools would ground out because th metal dust got into the motors When two or more tools went ou together, fireworks usually resulte if the grounds were on differen phases of the 3-phase, 220-volt, 360 cycle circuit feeding the tools.

To detect a ground condition before excessive damage could occur the plant maintenance electricia added a simple ground detectin device to the circuit. It consiste of three 220-volt pilot lamps star connected to the 3-phase circui The mid-point of the star wa grounded. Thus, with two lamp in series across each phase, th lamps all glowed at half-brillianc under normal operating conditions


220-v, 3-ϕ, 360 cycle circuit
Tool motor
220-volt pilot lamps
Ground detector
Ground on tool causes two lamps to glow bright

GROUND DETECTOR for high-cycle to circuit. The 220-volt pilot lamps are sta connected placing two lamps in seri across each phase of the 220-volt, 36 cycle, 3-phase circuit. Mid-point of sta is grounded. All lamps burn at half-brilli ancy under normal conditions; two glo brightly when a ground occurs.

ew, cool Sola ballast for two 1500ma lamps gives full light output, features upside-down case



gn features of upside-down ballast assure
st in-fixture operating temperatures:

ber insulator now at label surface. **B** No
mal barrier at mounting surface to trap
normal ballast heat, fixture is improved cooling fin. **C** Maximum space between capacitor and core structure gives full capacitor life. **D** Ballast temperatures substantially lower than competitive ballasts (see table at right).

Comparative Test Results

Ballast	Temperatures ° C		
	Case	Capacitor	Copper
Sola 670-130	80	60	87
Ballast X	81	70	92
Ballast Y	86	60	97

Ballasts tested in industrial fixture suspended one foot beneath ceiling while operating two, 8-foot 1500ma lamps. Ambient room temperature 25° C.

west member of Sola's growing
mily of upside-down fluorescent bal-
ts is Catalog No. 670-130. It oper-
s two 96-inch 1500ma lamps down
0°F, or two 72-inch 1500ma lamps
wn to —20°F.

The new ballast delivers full light
tput and is the coolest-operating,
-inch, single-case unit of its type
t we've tested. Results of in-fixture
mparative tests of the Sola ballast
d two of its competitors are shown
ove. Further tests prove that Cata-
No. 670-130 easily meets latest
CBM specifications for two-lamp 1500ma ballasts.

A good share of the new unit's improved performance and life-extending operating temperatures is a result of Sola's ingenious solution to the problem of heat dissipation which is diagramed above.

The next time you need a ballast that will help quality fluorescent fixtures deliver all the light that's engineered into 1500ma lamps, that will give coolest possible in-fixture performance, that will live up to its own rated life, that's the time to specify Sola Catalog No. 670-130. Engineers and fixture manufacturers are invited to send for sample ballasts.

Write for Bulletin 26H-FL

SOLA
A DIVISION OF
BASIC PRODUCTS CORPORATION
B P
C

Sola Electric Co., Busse Rd. at Lunt, Elk Grove, Ill.

easy
pull-through

WITH
BERMICO®
ELECTRICAL
CONDUIT

The inside walls of BERMICO Electrical Conduit are extremely smooth, permitting easy and safe passage of cables with no danger of sheath abrasion.

And there are many other important reasons why more and more engineers, contractors, and utilities are specifying BERMICO Bituminized Fibre Conduit. Light weight standard 8 ft. lengths, waterproof and acid resistant, hi-dielectric strength . . . easy and fast on-the-job cutting and joining, precision milled joints seal tight with a few hammer taps . . . BERMICO provides permanent, low cost installation and maintenance of power and telephone cableways.

BERMICO Conduit and Fittings are made to such high and precise standards, they surpass Federal Specifications for concrete encased cableways.

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Distributed by **WESTINGHOUSE** Electric Supply Company and Agent Jobbers in all principal cities.

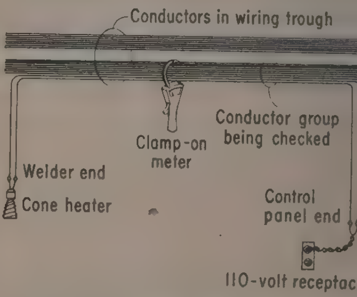
When a ground occurred on o
of the tools, two of the detect
lamps glowed brightly indicating
ground condition existed. The to
were then disconnected from t
circuit, one at a time, until t
three lamps returned to half br
liancy again.

Use Clamp-On Ammete
To Identify Circuits

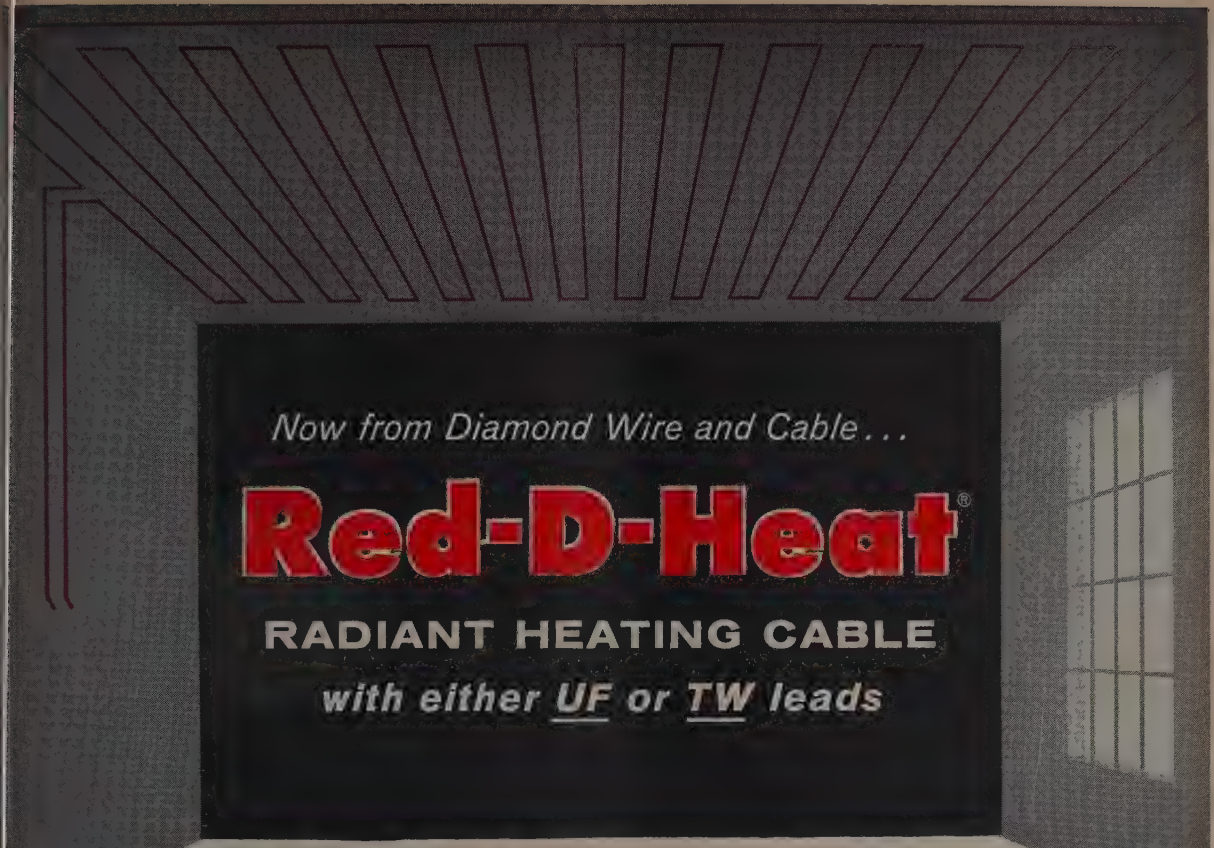
A number of gun-welders in t
production line of an industr
plant were connected to trough-e
closed conductors some distan
from the welder firing-pane
There were 30 or more unidentif
wires in the long wiring troug
Finding the seal-off valve a
thumb-switch circuits among the
conductors was somewhat of
problem when a change in weld
set-up was desired.

Use of a clamp-on ammet
solved the circuit identificati
problem in the following mann
The ends of the circuits in questi
were disconnected at the welder a
at the control panel. Then, wor
ing on one circuit at a time, one e
was connected to a socket conta
ing a cone-type resistance heat
The other end was plugged into
110-volt receptacle. At a pred
termined point in the long wiri
trough, a group of conductors we
lifted out and a clamp-on ammet
placed around them. No readi
on the meter indicated the circ
under test was not in that grou
Other groups were tried until
meter reading was obtained. Th
meant that the circuit in questi
was in that particular group.

Individual conductors of the "
dicating group" were then check
separately with the meter. Tho
with no reading were replaced
the trough. The two wires of t
test circuit carrying curre
showed a meter reading and we
identified and marked according



CLAMP-ON AMMETER UNCOVERS te
circuit conductors among maze of u
dentified wires in trough. Wires in gro
showing meter reading are then check
singly to identify current-carrying circu



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with either UF or TW leads

Here it is . . . dependable Red-D-Heat radiant heating cable available in your choice of either UF or TW non-heating leads. The TW is nylon jacketed and color coded to identify wattage and voltage. The UF lead, also color coded, now allows you to use Red-D-Heat without first installing and then “fishing” through a loom. And, remember . . . the complete Red-D-Heat line is manufactured under strict quality control to deliver “full capacity”.

240 VOLT SETS

CAT. NO.	WATTS	BTU
RHC 404	400	1365
RHC 406	600	2047
RHC 408	800	2730
RHC 410	1000	3413
RHC 412	1200	4095
RHC 416	1600	5461
RHC 418	1800	6143
RHC 420	2000	6826
RHC 422	2200	7509
RHC 425	2500	8533
RHC 430	3000	10239
RHC 436	3600	11287
RHC 446	4600	15700

208 VOLT SETS

CAT. NO.	WATTS	BTU
RHC 005	520	1772
RHC 007	700	2385
RHC 010	1040	3550
RHC 013	1390	4750
RHC 017	1730	5900
RHC 019	1910	6520
RHC 021	2170	7400
RHC 026	2600	8870
RHC 031	3110	10600
RHC 040	4000	13650

120 VOLT SETS

CAT. NO.	WATTS	BTU
RHC 202	200	682
RHC 203	300	1023
RHC 204	400	1365
RHC 206	600	2047
RHC 208	800	2730
RHC 209	900	3071
RHC 210	1000	3413
RHC 211	1100	3754
RHC 212½	1250	4266
RHC 215	1500	5122

Write today for information describing the complete Red-D-Heat line

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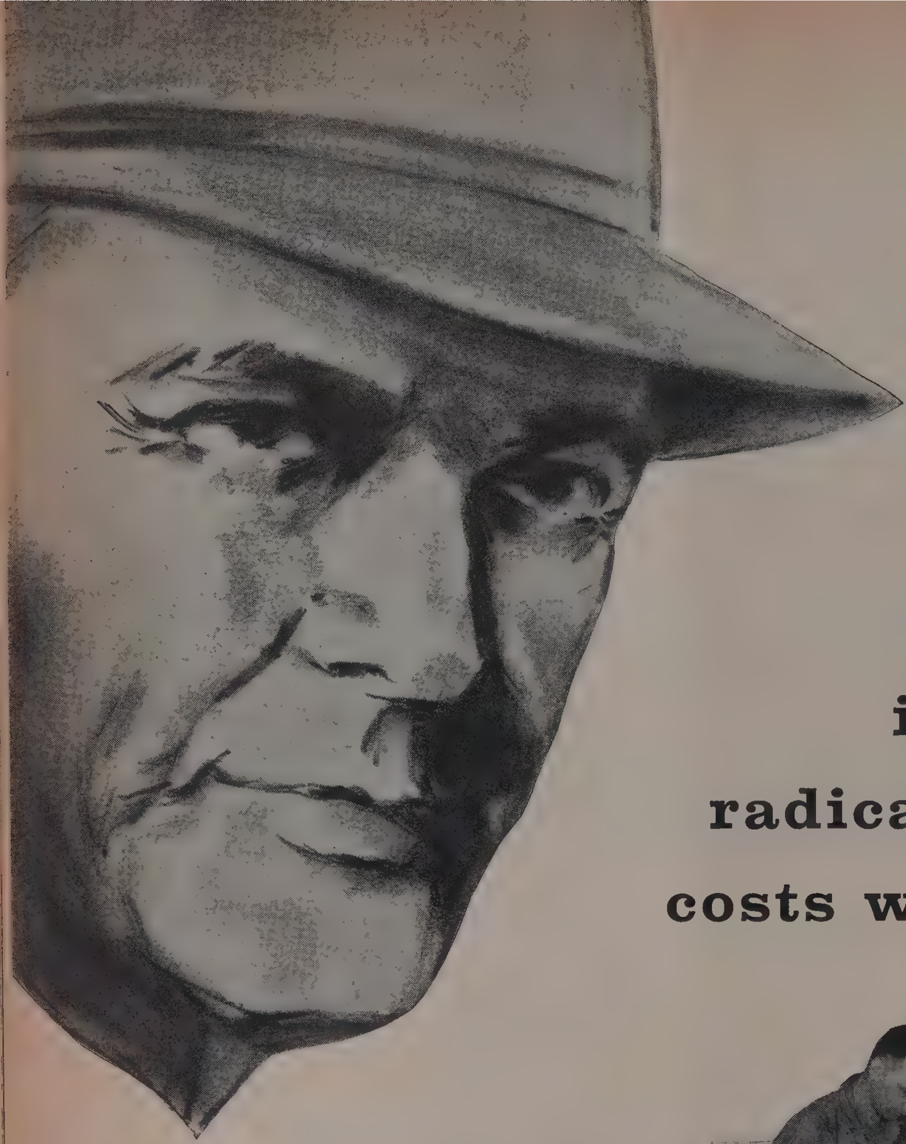
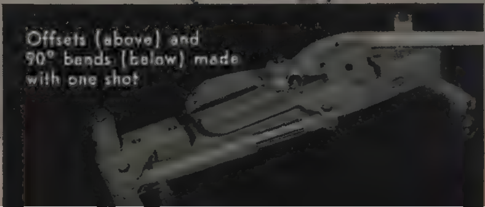


Look at ho
contracto
are speedin
installation
radically reducin
costs with Greenle
JO



Offsets (above) and 90° bends (below) made with one shot

As the bidding gets tighter and the profit squeeze grows tougher, today's smartest contractors are "tooling up" in every practical way to streamline operations — *control* costs!

Many are finding the answer in *Job-Profit Tooling* by Greenlee. It saves costly materials, mechanizes much of the work previously done by hand — assures extra efficiencies, better final results, *more net profit per job!*

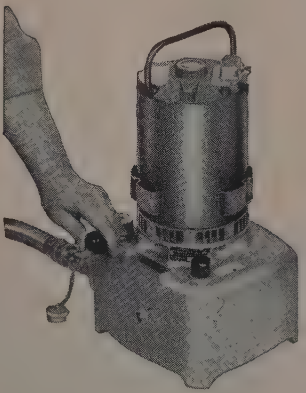
To illustrate — the new Greenlee Multi-purpose Hydraulic Bender at right makes offsets *in seconds* with one setting, one shot. Other Greenlee Job-Profit Tooling ideas to bring you additional time and materials savings are shown on the facing page.

IDEA FOR FAST, ON-THE-JOB CONDUIT BENDING—Greenlee No. 884 Lightweight Hydraulic Bender with portable power pump, shown above, makes 90° bend in 4″ conduit in about four minutes with one shot. Handles ½″-4″ sizes of steel and aluminum conduit and pipe.

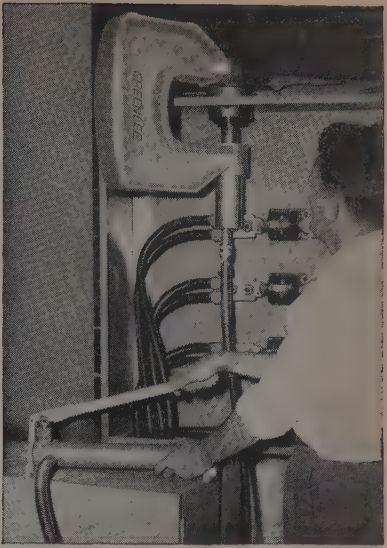
Greenlee Lightweight Hydraulic Benders are also available in two other models: No. 880-M2 for ½″-2″, and No. 883 for ½″-3″ conduit and pipe. No. 880-M2 with power pump makes 90° bend in 2″ conduit in less than a minute. No. 883 with power pump makes 90° bend in 3″ conduit in about a minute.

All models make full 90° bend with one ram stroke and are easily operated by one man with hand or power pump. Portable . . . carried by one man or wheeled from job to job on pipe supports which serve as rollers. Conduit is easily inserted and removed from front of bender . . . "Quick-Removal," positive-locking support pins cannot come loose. Attachments also available for bending thin-wall, bus bar, and tubing.

The Greenlee line also includes segment-type hydraulic benders, hand benders, and ratchet hand benders to give you a full complement of tooling for speeding every conduit-forming job.

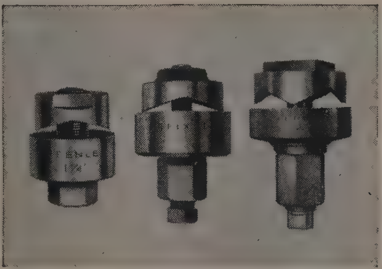


IDEA FOR FASTER BENDING—Convert from hand to power pump. Many contractors are finding the value of power operation over their previous hand-operated equipment. Power pumps increase bending speed from 3 to 5 times. A complete line of power pumps available with electric motors or gasoline engines. Illustration above shows the popular 798 AC-SA pump with ¾ hp, 110-220 volt a-c motor.



IDEA FOR CUTTING CONDUIT OPENINGS WITH NO PRE-DRILLING OR STEP-UP PUNCHING—Save yourself many dollars on conduit installations with Greenlee One-Shot Knockout Punch Driver that features high-strength aluminum "C" frame which fits around a junction box. Fast one-man setup and operation . . . lightweight and powerful. Punch cuts through 10-gauge steel with few strokes of hydraulic pump handle. Two sizes: No. 1732 (above) punches holes for ½″-4″ conduit, No. 1731 also available to punch holes for ½″, ¾″, 1″ conduit.

PROFIT TOOLING



IDEA FOR FASTER RESULTS ON ALL KNOCKOUT PUNCHING JOBS—With a Greenlee Hydraulic Knockout Punch Driver holes are made in seconds for conduit up to 5″. This operation is many times faster than the wrench method, and cutting is possible in cramped quarters—no wrench space needed. Your timesavings can quickly pay for this highly efficient tool. Designed to drive all Greenlee knockout punches, it is available singly for punches already owned or in handy sets with 6 or 10 punches.

Greenlee makes a complete range of knockout punches for conduit ½″-5″. Fast, easy cutting through 10-gauge metal. Every cut is quick, clean—slug falls free in die. No. 735 set in leather case for ½″-1¼″ sizes; No. 737 set in leather case for 1½″ and 2″ sizes. Other sizes individually packaged.

Job-Profit Tooling by Greenlee includes more than 100 different types and sizes of timesaving equipment specifically developed for the electrical worker. To help you select those that will "tool up" your operation for better job profit, write today for new illustrated quick-reference Bulletin E-240.

GREENLEE TOOL CO.
1878 Columbia Ave., Rockford, Ill.

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GREENLEE

JOB-PROFIT TOOLING

...cost control for contractors

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assures Quiet Quality dry-type transforme performance that's the finest in the industr

Since 1916 the principal products at Sorgel Electric Company have been dry-type transformers. Because of this long-time pioneering, specialization and experienced engineering, Sorgel customers are assured of continuous, more dependable transformer performance.

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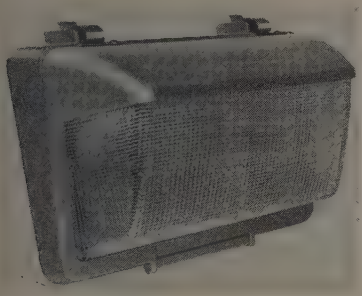
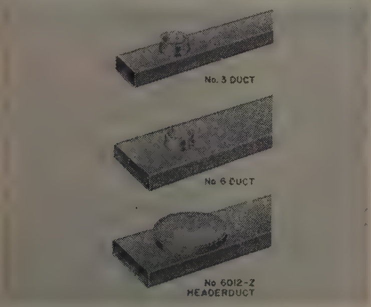
Product News



Luminaire (1)

The 480 Series wall-mounted luminaire for 300-watt lamp is designed for outdoor wide-spread lighting. Prismatic refractor is of shock-resistant Endural glass. Cast-aluminum, weatherproof housing with reflector, holds lens and has stainless-steel hinge at bottom on which face of unit rotates for access. It can be installed through three mounting holes.

Holophane Company, Inc., 342 Madison Ave., New York 17, N. Y.



Underfloor Systems (2)

Two new underfloor electrical distribution systems are designed for use in both new construction and modernization. Standard underfloor duct systems, known as "Wheatlanduct" is made of 14 gauge steel in two sizes. Catalog No. 3 has cross section of 1½ in. deep by 3 in. wide; Cat. No. 6 is 1½ in. deep by 6½ in. wide. Both ducts are made in 10-ft lengths with 2-in. pipe size threaded outlets spaced every 24 in. The Zamac outlets are 1-in. high and capped. A complete line of junction box units and component assembly parts is included for the system, which may be installed singly or in combination to form a single, double or triple duct system.

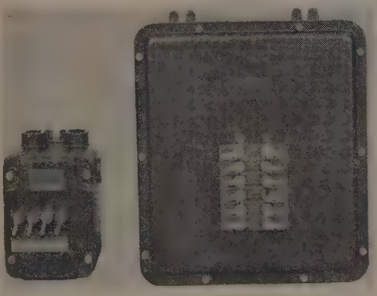
New Headerduct cellular metal floor feeder raceway Series 6000 is made of 14 gauge steel and is furnished in 8-, 9- and 10-ft standard lengths. Wide access openings are spaced on 12-in. through 120-in. centers as required to fit electrical design layout. Duct has cross section of 1½ in. by 6½ in. Headerduct is provided with removable capped access openings or with junction ring access units featuring outside adjustments to finished floor surface. Systems are listed by UL. Service fittings, die-cast aluminum, less than 3 in. high, are available with standard receptacles of 15- to 50-amp capacity, with openings for telephone and intercom use.

Wheatland Electric Products Company, 7308 Church Ave., Pittsburgh 2, Pa.

Panelboards (3)

A new line of distribution panelboards with enclosed magnetic starters is rated 600 volts ac maximum. Magnetic starters are used in NEMA Sizes No. 0 through 3, with 50-hp rating maximum. Starters are mounted in twin-unit construction and are arranged for panelboard mounting directly below disconnect devices. Starter line terminals are wired to either circuit breaker or fusible switch. Each starter is individually compartmentized and equipped with removable cover. All components are listed with UL. Bulletin GEA-6728 is available.

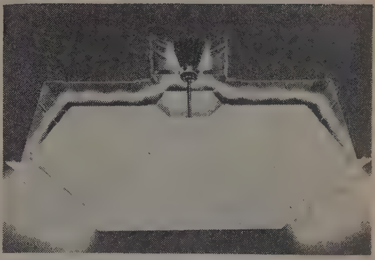
General Electric Co., Distribution Unit, 90 Whiting St., Plainville, Conn.



Lighting Panels (4)

New 4-circuit lighting panel is suitable for NEMA 4, 5, 7 and 9 use. Four cast hubs are provided and mounting slots make installation simple on any type surface. New 12-circuit lighting panel is for use in NEMA 4, 5 and 9 applications. It is also available in 24-circuit size. Circuits can be added in the field up to the total capacity of the equipment.

Nelson Electric Mfg. Co., Tulsa, Okla.



Lighting and Air Diffusing (5)

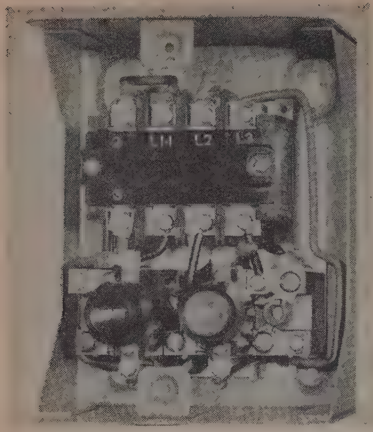
A complete line of combination lighting and air-diffusing equipment units are available in both 12- by 48-in. and 24- by 48-in. sizes, with a wide choice of lighting enclosures including louvers, plastic and glass. Conventional Day-Brite troffers and Mobilex can be integrated with combination units in same installation and allows adaption of lighting systems to changing space and task requirements. Supply and return air distribution elements are interchangeable in any location from the same unit. Unit retains full width luminous area. Double-wall construction allows air to pass through separate chamber.

Day-Brite Lighting, Inc., 6260 N. Broadway, St. Louis 15, Mo.

Panelboard (6)

Ratings of the line of NQO panelboards have been expanded so that protection for power loads can now be combined in the same panelboard with lighting and appliance circuits. They feature plug-in construction for on-the-job assembly. Basic devices are available with main lug ratings up to 600 amps. Type QO and Q1 plug-in branch circuit breakers are offered in 1-, 2- or 3-pole construction with ratings from 15 to 100 amps.

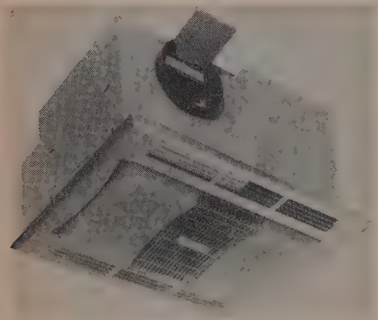
Square D Company, 1601 Mercer Road, Lexington, Ky.



Starter (7)

New Size 00 starter is designed for use with both polyphase and single-phase motors, and is available either as open type or in a NEMA Type 1 enclosure. Size is 5¾ in. wide by 7 in. high by $4\frac{3}{16}$ in. deep. Cover control offered consists of "Reset" only; "Start, Stop-Reset" and "3-position selector switch." Ratings for Size 00 are: 3 phase, 110 volts, ¾ hp, 208/220 volts, 1½ hp, 380/440/550 volts, 2 hp; and single phase 115 volts, ⅓ hp, 230 volts, 1 hp.

Cutler-Hammer, 315 *N.* 12*th St.*, *Milwaukee, Wis.*



Electric Heating (8)

A new line of ceiling-mounted residential electric heating equipment. It includes three different models that are especially suited for installations in kitchens or bathrooms. Each unit mounts in a recessed position into the ceiling. Line includes a heater-light-fan which combines in one device a 1200-watt heating capacity, two 60-watt lamps and a 175 cfm fan. It can be mounted between joists. A 5¼-in. dia. squirrel-cage blower circulates heated air and exhausts stale air. Horizontal exhaust can be adapted to any standard 4-in. round duct. A special wall switch allows separate use of heater, light and fan. A compact heater-and-light unit, rated at 1200 watts for heating and using two lamps and a unit with heater only, rated at 1000 watts, is also available. All ceiling model electric heaters include built-in thermal protection devices that turn off to prevent overheating. Units are designed for installation in new or existing houses.

Westinghouse Electric Corp., Air Conditioning Div., Staunton, Va.

Outlets (9)

A new series of outdoor power outlets in both fused and circuit breaker types for outdoor construction, farms, industry, and mobile home parks. Model P-55-F has a 50-amp, 250-volt, 4-wire receptacle with U-type grounding blade. It is protected with a 2-pole 60-amp pull-out block. Also, has a grounded type duplex receptacle protected with a separate fuse. Top hub and three knockouts at bottom facilitate overhead and underground connections. Completely weatherproof and can be padlocked. Catalog is available.

Midwest Electric Products, Inc., Mankato, Minn.

Switch (10)

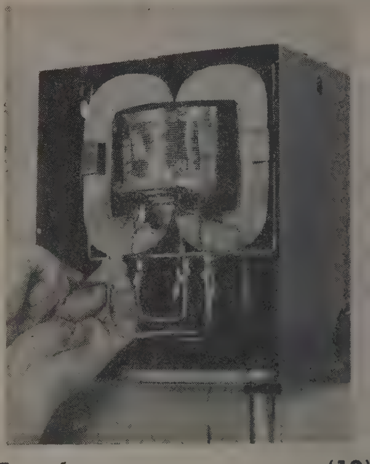
A new 15-amp, 120/277-volt ac touch switch can be installed in any position and will provide non-stalling action with a gentle touch from any angle. It is 1-in. in depth and has special heavy silver contact points. Unit is side wired for convenience; has large head brass terminal screws; backed out and staked which accommodate up to No. 10 conductors; and is interchangeable with any standard switch and wall plate. It will accommodate high inductive loads of fluorescent systems or full rated capacity of incandescent filament lamp loads. It is recommended for the new 4-wire electrical systems requiring switches rated at 277 volts in all applications from homes and schools to hospitals and plants.

Leviton Manufacturing Company, Inc., Brooklyn 22, *N. Y.*

Electric Heaters (11)

Chromalox electric console unit heaters are designed for installation in all types of buildings. Basic unit is available in free-standing, semi-recessed or full-recess models which, in turn, can be mounted in floor, wall or ceiling positions. With heating elements, centrifugal fans, and temperature controls all mounted in a single cabinet, the heater is adaptable in either new or remodeled building projects. Heating capacities range from 8,200 Btu/hr to 102,500 Btu/hr. Automatic night temperature set-back operation is also available. Bulletin No. F21100 is available.

Edwin L. Wiegand Company, 7500 *Thomas Blvd.*, *Pittsburgh* 8, *Pa.*

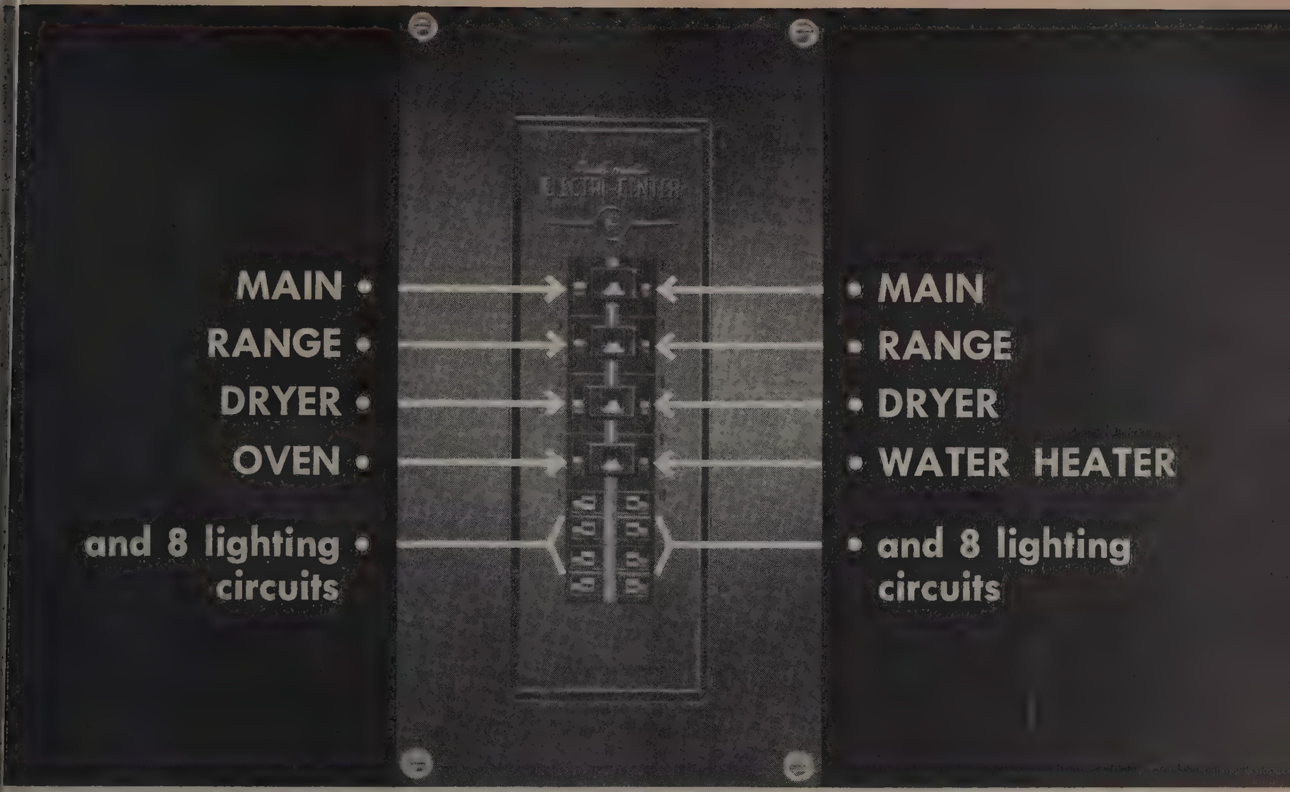


Transformer (12)

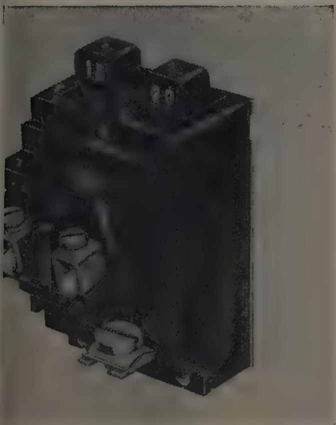
A new line of general-purpose, ventilated, dry-type transformers in ratings 3 through 50 kva, single phase, 600 volts and below, are designed for indoor use. Three-piece case has convenient knockout locations to permit standard-size conduit to be connected from either side or bottom. Coils are wound with high-temperature epoxy-film insulated wire.

Allis-Chalmers Manufacturing Co., Milwaukee 1, *Wis.*

GET THIS . . . . OR THIS



ONLY IN BULLDOG'S 12-CIRCUIT ELECTRI-CENTER®

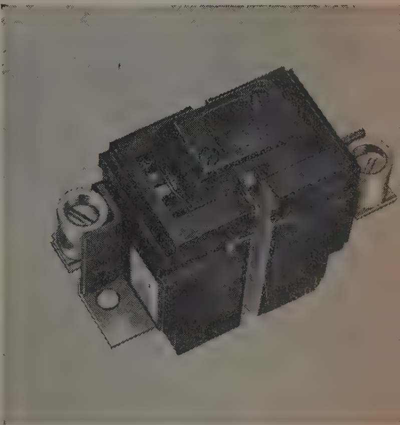


New Duplex Pushmatic puts two circuits n the space of one single breaker. Gives: dentical, independent coil-magnetic pro-ection in each pole of all Duplex oreakers; positive one-bolt connection; pushbutton convenience.

Only BullDog Pushmatic circuit breakers give you both of the above combinations—plus many others—in a 12-circuit panel. Other breakers would need a 16-circuit panel.

The BullDog Pushmatic® 100-amp breaker takes only two spaces, compared to the four spaces needed for any competitive 100-amp breaker. And new BullDog Duplex Pushmatic puts two lighting circuits in a single space. Count 'em . . . all the circuits shown in only 12 spaces!

You save space by using smaller panels. You provide the maximum in electrical circuit flexibility and protection. Pushmatic protects two ways—coil short-circuit and thermal overload protection. To put more electrical services into less space, see your BullDog products representative.



Pushmatic 100-amp breakers take only two spaces compared with four spaces required for all competitive 100-amp breakers. Pushmatic 100-amp breakers are now available for field installation.

BullDog Electric Products Division, I-T-E Circuit Breaker Company, Box 177, Detroit 32, Michigan.
In Canada: 80 Clayson Rd., Toronto, Ont. Export Division: 13 East 40th St., New York 16, N. Y.

®

BULLDOG ELECTRIC PRODUCTS DIVISION
I-T-E CIRCUIT BREAKER COMPANY

Mr. Jerry Shaw of Shaw Electric, electrical contractor for Justice Elementary School, Justice, Illinois, says:

"Honeywell helped us install Central Security System

Mr. Jerry Shaw, in one of the classrooms in Justice Elementary School. Automatic detectors in the classroom will detect fire without fail and immediately ring alarms in the building and at the fire station.

our first without a hitch”

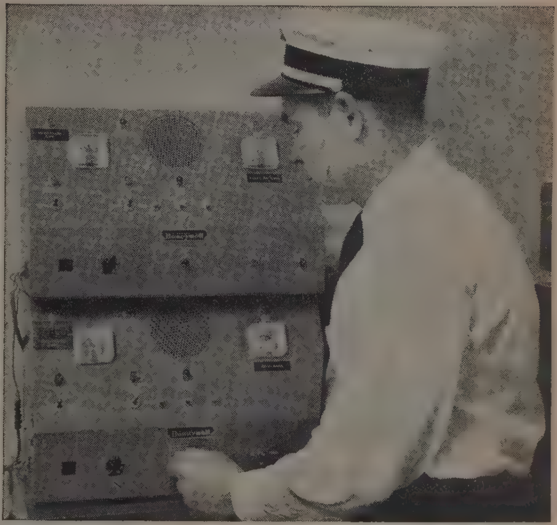
Honeywell planned the system for Justice Elementary School down to the last detail—then supervised its installation and checked it out to make sure it operated perfectly.

“This was our first attempt at installing a Central Security System,” says Mr. Shaw. “And with Honeywell’s help, it went off without a hitch. Honeywell engineers saw that the equipment was delivered on schedule and not only supervised the installation, but stayed on to check it out.”

The Honeywell Central Security System in Justice Elementary School protects the building against both fire and vandalism. Twenty-two automatic fire detectors are located throughout the school. They detect fire when it breaks out and automatically sound alarms to clear the building and notify the fire department.

The system also includes Honeywell intrusion detectors, installed at key locations in the building. They detect intrusion and automatically sound an alarm at police headquarters. In addition, the system provides intercommunication between the school and police headquarters to enable the police to listen for suspicious noises.

You’ll find your job always goes smoothly when you work with Honeywell. Help is conveniently available from any of the 112 offices across the nation. Call your local Honeywell office. Or write Honeywell, Dept. EC-8-150, Minneapolis 8, Minnesota. In Canada, write Honeywell Controls, Limited, Toronto 17, Ontario.



Mr. Joseph M. Stimatz, Chief of the Justice Fire Department, operates the Honeywell Central Security Panel at fire and police headquarters. Both fire and intrusion will automatically be reported here so that help can be dispatched without delay.

Honeywell

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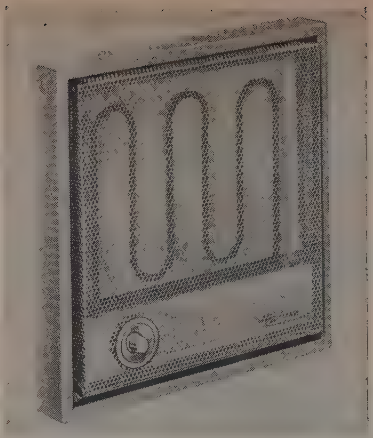


Electric Heater (13)

A new automatic electric heater that hangs on a wall like a picture is available. In the back there are three keyhole slots for mounting, and there are knockouts for electric wiring in back and in bottom. Solid aluminum reflector, enclosed heating element. Built-in thermostat. Baked enamel finish, 2½ in. deep, 14½ in. high. Available in two sizes —750 watts, 2,562 Btu. and 1000 watts, 3,415 Btu, 120 volts. UL approved. Literature is available.

Cavalier Corp., Chattanooga 2, Tenn.

Compression Taps (14)

The introduction of compression taps completes the Color-Keyed line of lugs, 2-way connectors, pigtails and installing tools. This C Tap is one-piece construction. Nine C Tap sizes will tap any two code copper conductors from two No. 10's to two 1/0's and any combination of large main to smaller branch from No. 10 to 3. Color bands on C Tap match corresponding colors on the dies of installing tools assuring correct compression and permanent installation. Brochure is available.

Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.

Connectors (15)

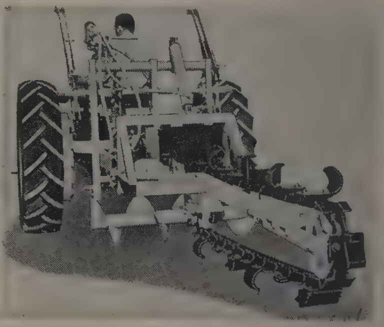
Two new malleable iron two-screw type, open-throat clamp connectors are designed to accommodate armored cable, flexible cable, flexible conduit, non-metallic sheathed cable, rubber-jacketed cords and service-entrance cable. Reversible clamp connectors now available for round or oval shaped cords. These connectors will house conductors ranging from .218 in. to 1 in. The other is one of five clamp connectors made to accommodate oval-shaped cords. These connectors will cover a range from .310 in. to a maximum of 1.09 in. Another type available is made to accommodate round conductors. This style is sized for a minimum opening of .355 in. to a maximum of 1.29 in.

Gedney Electric Company, RKO Building, Radio City, New York 20, N. Y.

Lightning Arrester (16)

Type DS crystal valve lightning arrester is 4 in. shorter than the model it replaces and 20% lighter. Length, weight and voltage discharge savings have been achieved through an improvement in grain structure of oxidized silicon-carbide "Crystallite" valve element. Long leakage distance is maintained by new contour of porcelain body.

Delta-Star Electric Division, H. K. Porter Company, Inc., 2437 Fulton St., Chicago 12, Ill.



Ditcher (17)

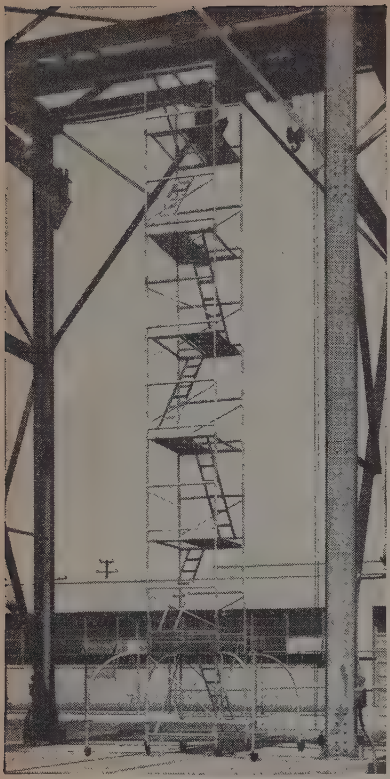
New 3P Pow-R-Ditcher is specifically designed to fit all 3-point tractor hitches. It has a digging width of 6 to 16 in. wide and will dig to a 4½-ft depth. Digging chain is the same as used on the largest Vermeer ditchers. Tractor-mounted ditcher features an all-new hydraulic-actuated travel-ratchet device that gives full control of digging speed from one control lever. The power is taken from the tractor's hydraulic system. The PTO shaft is equipped with a double disc friction slip clutch for digging safety.

Vermeer Manufacturing Company, Pella, Iowa.

The men who really know...know Efcor

Meet Bill Reynolds, a man with his head in the clouds and his feet planted firmly on the ground. Electrical General Foreman for Fischbach & Moore Inc. and L. K. Comstock & Co., a joint venture, Bill has over 33 years of skyscraper construction experience behind him. Ask Bill about electrical fittings and boxes and he'll tell you he's always glad to hear that Efcor's on the job. That's his assurance of products manufactured with the engineering, the quality and the features that mean greater efficiency and a better job done for Bill and his men. Like Bill Reynolds, all across the country you'll find the men who really know . . . know EFCOR.

ELECTRICAL FITTINGS CORPORATION · WOODSIDE 77, N.Y.



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by PS CO.

raise efficiency
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When maintenance or repair goes above arm's reach, you can **control costs** with PS CO. Rolling Scaffolds . . . all bearing U.L. Label.

steel —"Trouble Saver" Rolling Scaffolds are erected from simple, easy-to-assemble parts. End frames, 2', 3' or 5' wide, are joined by pivoted diagonal braces to form the basic unit. Additional frames are placed on top of the original basic unit by means of sprockets.

or aluminum — Sectional Scaffolds are erected from separate frames, braces, and stairways. Base dimensions are 4'6" x 6'. 29"—or 4' 6" Wide Sectional Ladder Scaffolds available in 6', 8' or 10' spans with ladders 4', 5'4" and 6'7" high. "Fold-A-Way" Scaffolds go up without acrobatics, flip-flops. Base unit 7' high, sections 6'. Base—4'6" x 6'.

Write for Bulletin G-205RR

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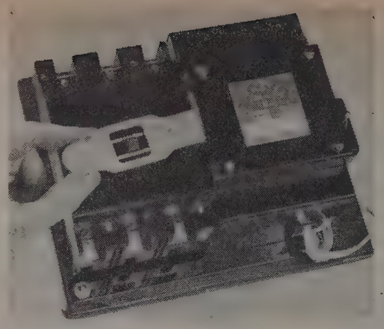


Operators (18)

A line of electrical operators that allows Type AB circuit breakers to be remotely controlled is now available. Models with rated control voltages of 120, 240, 480 or 600 volts ac and 125 volts dc can be supplied. They will actuate breakers rated to 100 amps at 600 volts in frame sizes designated E, EH and F. Breakers that are mounted in panelboards, switchboards or busduct plug-in units can be equipped with the new operators. Mounting holes for operators are identical in spacing and size to those for breakers in all three available frame sizes. For back mounting, a special pin can be supplied.

Westinghouse Electric Corp., P. O. Box 2099, *Pittsburgh* 30, *Pa.*

Lighting Fixture (19)

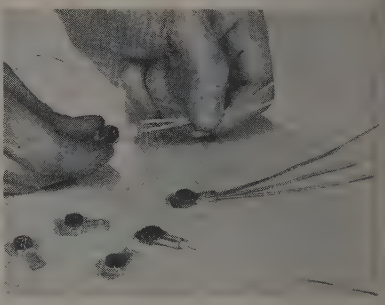
A new lighting fixture, called the Chelsea, is a plastic-enclosed unit, measuring 13 in. wide. It comes equipped with either acrylic or polystyrene shielding. Available in 2-, 3- and 4-light units, it may be surface-mounted with top reflectors, or pendant-mounted. Slide-grip hangers are used for hanging the uplighting units.

Smithcraft Lighting, Chelsea 50, *Mass.*

Electric Furnace (20)

Electric furnace for central forced-warm-air applications has an output of 39,000 Btuh. Features include air circulation to prevent air stratification and staleness; provides air filtering; fresh air can be introduced into system; humidity can be controlled; air purifiers can be added. The "ES" series can be installed as a horizontal unit, an upflow unit or a down-flo unit. It is 42½ in. long, 19 in. high and 17 in. deep. The "hammock" type filter is 18 by 24 in. Unit is UL listed. Units now being produced are single phase. Following are heating outputs with varying voltages: 208 volts 31,800 Btuh; 220 volts 35,700 Btuh; 230 volts 39,000 Btuh; 240 volts 42,500 Btuh.

Lennox Industries Inc., Marshalltown, Iowa.



Connector (21)

A self-stripping communication wire connector developed for the telephone, communications and signaling industries. Also self-sealing and preinsulated, the "Scotchlok" brand electrical connector Type UR, splices, insulates and moisture-seals in two steps. Connector is designed to accommodate any 2- or 3-wire combination of No. 19 to No. 26 AWG solid or No. 20 to No. 25 AWG stranded wire, and handles all common types of insulation, including plastic, rubber, enamel and teflon. It is made of a transparent thermoplastic material, filled with silicone grease, and incorporating a metal finger-like connector element. A crimping tool with parallel action jaws has been designed.

Minnesota Mining and Manufacturing Co., 900 *Bush Ave., St. Paul* 6, *Minn.*

Tool (22)

An automatic powder-actuated fastening tool, designated "Mark II," incorporates full interchangeability of all parts for "on-the-job" servicing. Design permits 8-shot cylinder to use longer nails and studs, now accommodating fasteners up to $3\frac{5}{16}$ in. overall. Fastener can be operated with two pre-loaded cylinders. Eight shots are fired successively from one cylinder, which then is replaced by second loaded cylinder, to give a total of 16 shots per minute.

Columbia-matic "8" Corp., Syracuse 1, *N. Y.*

A few of the many places where Sealtite guards electrical connections in the plant of Ecusta Paper Division of Olin Mathieson Chemical Corp., Pisgah Forest, N. C. Sizes range from ½" through 4" in Type EF black.

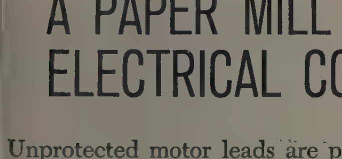
A PAPER MILL NEEDS LOTS OF WATER—BUT NOT IN ITS ELECTRICAL CONNECTIONS, WHICH STAY DRY IN SEALTITE

Unprotected motor leads are potential trouble spots in a paper mill—where they are constantly exposed to moisture, chemicals, and physical damage. The simple, economical answer is Sealtite, Anaconda's flexible, liquid-tight conduit, providing low-cost insurance against shutdowns due to machine hookup failures.

Wherever service conditions are rough—from moisture, corrosives, weather, movement, vibration, separately or in combination—Sealtite gives dependable protection to electrical wiring. Its tough, extruded polyvinyl jacket proves itself in arctic cold and tropical heat. It resists moisture, oil, dirt—even salt spray and corrosive chemical fumes. Its flexible metal core absorbs vibration. That's why Sealtite conduit often outlasts rigid conduit.

WHERE TO GET SEALTITE—Leading electrical wholesalers stock Sealtite in easy-to-handle coils, in black or gray. Be certain you ask for and get the quality conduit marked "Sealtite" and "Anaconda" on the cover. Buy it in long lengths on reels or in cartons and cut it on the job to eliminate waste. Your wholesaler also stocks liquid-tight connectors. Free Booklet S-542 gives full information on Sealtite. Write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. Sealtite is approved by Canadian Standards Association.

60137



CUTAWAY OF Type U.A. Sealtite shows tough polyvinyl chloride jacket over flexible metal core. Copper conductor wound spirally inside conduit provides positive ground.

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Insist on the conduit marked

SEALTITE®

FLEXIBLE, LIQUID-TIGHT CONDUIT

an **ANACONDA®** *product*

NO BOLTS, NO SCREWS, NO DRILLING

with new Permacel Junction Box Mount epoxy adhesive
. . . the fast, easy way to attach junction boxes to any surface.

PERMACEL®

NEW BRUNSWICK, NEW JERSEY • TAPES • ELECTRICAL INSULATING MATERIALS • ADHESIVES

Troffer **(23)**

New fluorescent troffer is specially designed to combine with steel roof deck as a ceiling and lighting system. Adjacent roof deck cells can be closed off with acoustical material. Self-aligning hangers are used. Die-formed steel troffers are UL-listed with CBM-certified rapid-start ballasts. A wide choice of diffusers, including six stock models in formed acrylic, plastic louver, ventrolens, and glass, provides a selection of troffers for all applications. Bulletin is available.

Lighting Products, Inc., Highland Park, Ill.

Electric Furnace **(24)**

A new electric furnace, called "Electro-Flo," is for residential use. It features an exclusive "Selective-Sequencer," a modulating device which controls up to nine stages of heating, depending on capacity of furnace. Selective-Sequencer actuates from three to nine motor-operated switches, one for each pair of heating elements of approximately 10,000 Btu output. Air can be de-humidified or humidified. Furnace is available in four models, each offered for operation with 208, 220, 230 or 240 volts. "Electro-Flo" furnace and blower can be installed in any position, and same units can be arranged as vertical, counterflow or horizontal models at installation site. Summer cooling up to 5 hp can be added.

Stewart-Warner Corp., 1826 *Diversey Parkway, Chicago* 14, *Ill.*

Spring Operator **(25)**

A portable spring operator provides fast, trip-free snap action for positive motion in switching from any position to the next in a new line of Snapact load-break oil switches. Switching action is non-reversible and positive in the line. Spring operators weigh 25 lbs. The load-break oil-switch line will carry and interrupt full 400-amp load current and is available in 5-, 7.5- and 15-kv ratings. Switches can be provided for all applications and switching arrangements now available in standard Type RA line.

G & W Electric Specialty Co., 3500 *W.* 127*th St., Blue Island, Ill.*

Time Meters **(26)**

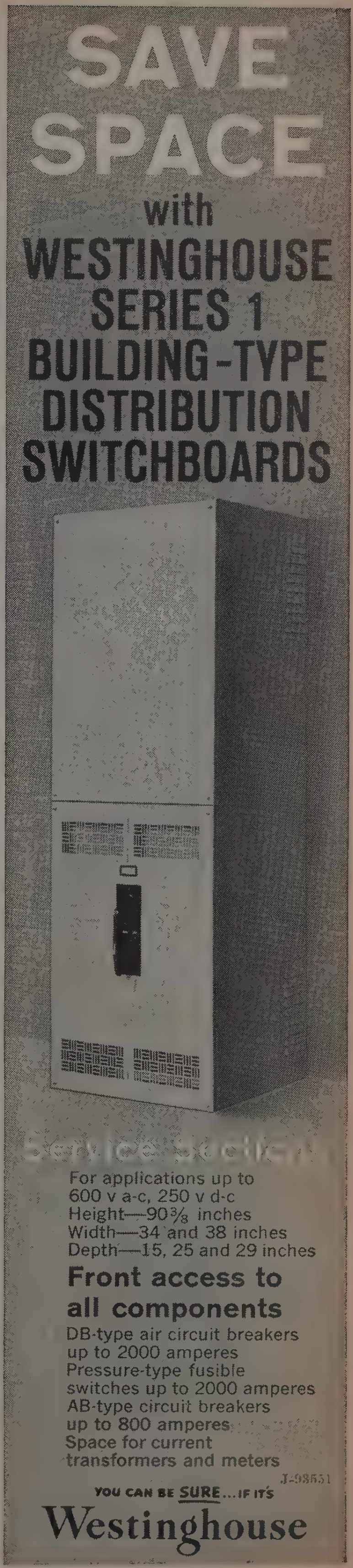
New 10-station time utilization meter panel, known as "Tump," consists of ten individual running time meters, each with its own signal light, in a steel housing, less than 7 by 13 in. Connects to ten different machines or operations to be monitored at distances to 5000 ft. It uses 26 volts. They are used to show production time, hours of machine use in plant. In office to determine wages, etc. When meters are accumulating time, corresponding signal light is visible. Bulletin is available.

Gorrell & Gorrell, 336 *Old Hook Road, Westwood, N. J.*

Fluorescent Fixture **(27)**

A new line of surface-mounted fluorescent fixtures, called the Vega, has a shallow depth of 3½ in. It is available in 12-, 18-, 24- and 48-in. widths, from a 2-lamp 1 by 4 unit to an 8-lamp 4 by 4. Offered in a variety of diffusers, aluminum or plastic eggcrates, inverted hexagonal prismatic "Starlite" lens, or the new polystyrene.

Metalcraft Products Company, Inc., 6225 *State Road, Philadelphia* 35, *Pa.*



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Service Section

For applications up to
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Height—90⅜ inches
Width—34 and 38 inches
Depth—15, 25 and 29 inches

Front access to all components

DB-type air circuit breakers up to 2000 amperes
Pressure-type fusible switches up to 2000 amperes
AB-type circuit breakers up to 800 amperes
Space for current transformers and meters

J-93551

YOU CAN BE SURE...IF IT'S

Westinghouse

A development of Orangeburg and Flintkote Research Laboratories, new *klean-kote* Orangeburg Conduit has a tough, non-brittle, protective coating for cleaner, safer handling. Ask your Wholesaler to show you a length now.

klean-kote* ORANGEBURG®
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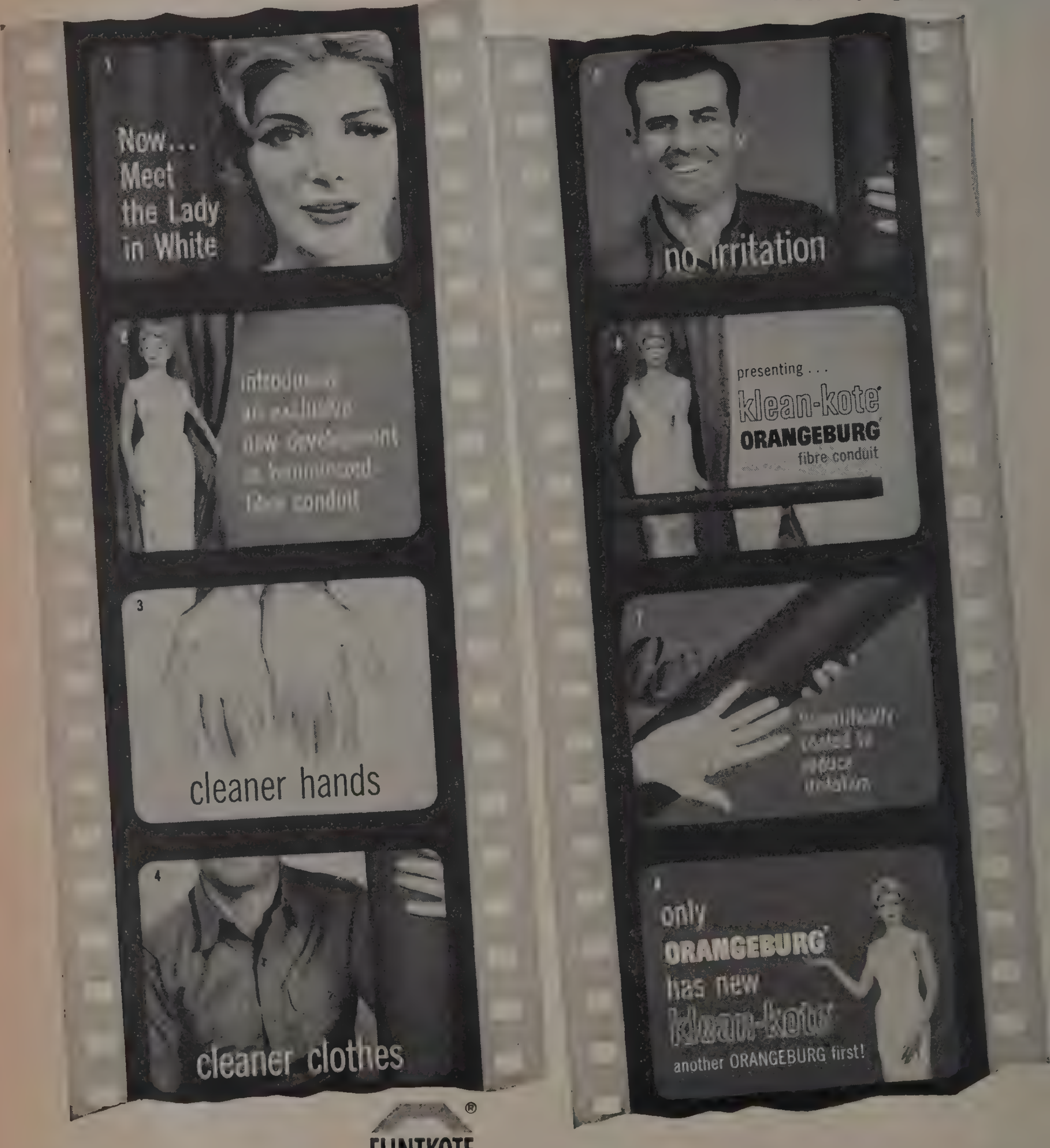

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Orangeburg Manufacturing Co., Orangeburg, N.Y. Division of The Flintkote Company, Manufacturer of America's Broadest Line of Building Products

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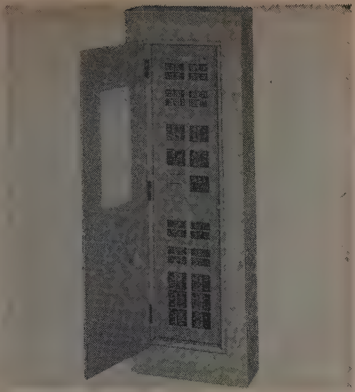
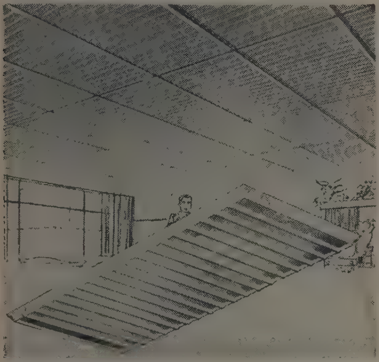


Load Center **(28)**

New 200-amp split bus "Twin" load centers is suitable for Gold Medallion Home electric heat applications. Available in both flush and surface design, panel, Cat. No. TRX4020, has space for six 2-pole breakers in the 200-amp main section, three of which serve as subsection mains, and accommodates up to 28 single-pole circuits with 1-in. TQL breakers or 30 circuits with 2-in-1 "Twin" breakers. Listed by UL, the single-phase, 3-wire device is suitable for use with 2-pole plug-in Type TQL and TQAL circuit breakers rated up to 100 amps.

General Electric Co., Plainville, Conn.



Lighting **(29)**

New Sky-Glo illuminated ceiling system is based on 2- by 4-ft and 2- by 2-ft vinyl, polystyrene and acrylic diffusers. It is also available with a variety of prismatic diffusers plus ½-in. cube aluminum or plastic louvers. Grid network is suspended directly from lighting element and inverted T-grid is of aluminum alloy. In addition, the line offers a wide selection of shielding elements and lighting equipment, including Power-Groove lamps, rapid-start, slimline and 800 ma high output.

Benjamin Division, Thomas Industries Inc., Louisville, Ky.

Receptacle **(30)**

In compliance with recent revisions to the NEC, a new line of 20-amp, 125-volt, 3-wire "U" ground devices has been added to this line. In addition to providing a receptacle for the 20-amp cap, the design permits the use of 15-amp, 125-volt, 3-wire "U" ground and standard parallel caps making it a "universal" receptacle. Line includes duplex receptacles in brown and ivory, duplex on 4-in. covers in brown, and armored caps.

Circle F Manufacturing Co., Trenton 4, N. J.

Outlet **(31)**

Designed for mobile home parks, Model 5217 weatherproof power outlet features a 50-amp, 125/250-volt "Life-Line" park receptacle, plus a 15-amp, 125-volt grounding type outlet to service travel trailers or for accessory use. A 2-fuse pull-out provides overload protection for the 50-amp receptacle and there is a plug fuseholder for the 15-amp outlet. Models with circuit breakers are also available. Plugs from mobile homes connect inside box and box cover can be closed and locked while receptacles are in use. There are conduit knockouts in bottom and a 1-in. hub in top or bottom of box.

Hoffman Engineering Corp., Anoka, Minn.

Dimmer **(32)**

The first of a series of four dimming controls, the electronic budget dimmer, P 8762, is for light control for any room in the house. Dimmer's three positions are "Hi," "Mood" and "Off"; and it replaces standard wall switch without changing wiring or wall plate. For incandescent fixtures and lamps to 300-watt capacity.

Progress Manufacturing Co., Caston & Tulip Sts., Philadelphia 34, Pa.

SAVE SPACE
with
WESTINGHOUSE SERIES 1 BUILDING-TYPE DISTRIBUTION SWITCHBOARDS

Distribution [illegible]

For applications up to
600 v a-c, 250 v d-c
Height—90⅜ inches
Width—34 and 38 inches
Depth—15 inches

Front access to all components

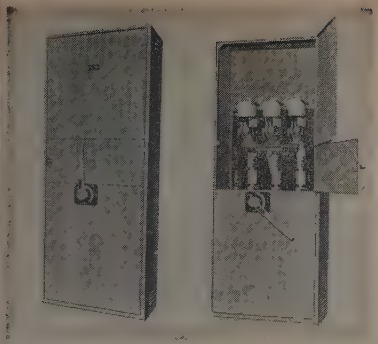
AB-type circuit breakers
up to 800 amperes
FDP-type fusible switches
up to 600 amperes J-93552

YOU CAN BE SURE ... IF IT'S
Westinghouse

If power fails... lights go on!

Yes, when the power goes off, Exide Lightguard® goes on automatically—prevents panic, injury and damage. Exide Lightguard plugs into any regular outlet—has a built-in automatic charger. Batteries last for years. You have a choice of several models. For full details, write Exide Industrial Division, The Electric Storage Battery Company, Phila. 20, Pa.

Exide®



Switch **(33)**

A new load-break service-entrance switch with safety and operating features is called Bolt-Loc. They can be furnished in 1200-, 1600- and 2000-amp capacities for 240-, 480- and 600-volt ac service. They are available in 2-, 3- and 4-pole switches, fused or unfused, for front or rear connection. Features include an interlock for fuse door; handle arranged for padlocking with up to four padlocks in both open and closed positions. All standard fusible switches include provisions for specified silver-sand high-interrupting-capacity fuses. If desired, switches can be mounted in steel or aluminum, free-standing, wall-type or other enclosures. Literature is available.

Barkelew Electric Mfg. Co., Middletown, Ohio

Wall Bracket **(34)**

All aluminum weathertight wall bracket is suitable for mounting in horizontal or vertical position, over doorways or adjacent to entranceways in schools, hospitals, police stations, fire houses, shopping centers and other public buildings. Fixtures can also be mounted under canopies, marquees, overhangs and covered walkways. Wiring is for either two 100-watt incandescent lamps or two 15-watt fluorescent lamps, and 4-in. cast aluminum junction box, gasket and machine screws for weathertight installation. Finished in satin anodized aluminum.

McPhilben Lighting, Inc., 1329 *Willoughby Ave., Brooklyn* 37, *N. Y.*

Ladder **(35)**

A fiberglass safety ladder called Himco. Rails are constructed of fiberglass-plastic channels which are bonded around a specially prepared hardwood core. It is electrically non-conductive. Fiberglass surface is splinter-proof, impervious to water, paint and solvents, and resistant to scratches, acids, alkalis, and other corrosive chemicals. All rungs are aluminum. Rope is made of polypropylene, which will support 3000 lbs.

Hopfeld Industrial Manufacturing Co., San Rafael, Conn.

Time Switch **(36)**

A new 55-amp, 7-day time switch is equipped to handle the heaviest lighting loads. Typical uses include control of indoor and outdoor (protective) lighting for schools, institutions, public buildings, industrial plants, for parking lot lighting. Individual On-Off lighting schedules for each day of the week can be set on 7-day dial. Lug terminals take up to No. 6 wire without bending. Units may be ordered without case but with bracket, or in flush enclosure for panelboard or recessed wall mounting.

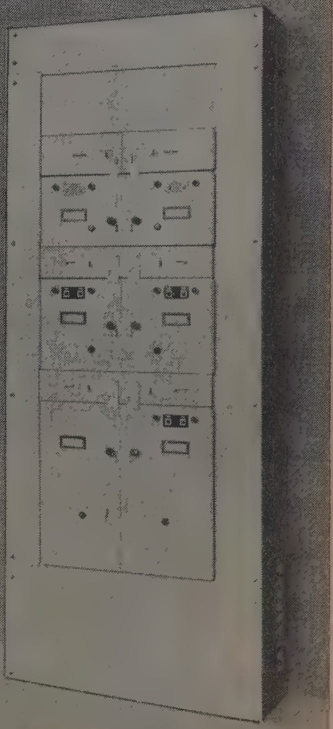
Tork Time Controls, Inc., Mount Vernon, N. Y.

Pushbutton **(37)**

A new lighted oiltight pushbutton with a "turn-to-test" feature. It offers the advantages of a push-to-test pilot light and lighted pushbutton in one unit. Before pushing button to start motor or other equipment, button is given a half turn. This energizes the lamp circuit without affecting the control circuit and shows whether or not lamp lights. Six color caps are available. Unit is equipped with heavy duty contacts. Literature is available.

Arrow-Hart & Hegeman Electric Co., Hartford, Conn.

SAVE SPACE
with
WESTINGHOUSE
SERIES 1
BUILDING-TYPE
DISTRIBUTION
SWITCHBOARDS



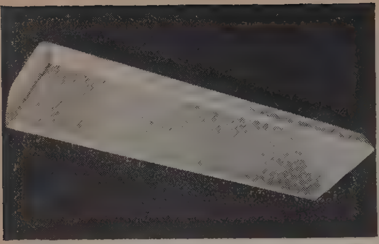
Distribution Section

Height—90⅜ inches
Width—34 and 38 inches
Depth—15 inches

Front access to all components

Motor starters up to Size 4
Interlocked AB circuit breaker disconnects
Interlocked FDP fusible switch disconnects J-93553

YOU CAN BE SURE ... IF IT'S
Westinghouse



Luminaire (38)

A new line of Trend Series fluorescent luminaires specially designed to provide high level illumination for schools and offices, at recommended standards for visual comfort. Design includes completely luminous wrap-around side panels. A choice of three diffusers is offered: clear ventrolens, white ventrolens, and a polystyrene egg-crate louver providing 55° shielding both crosswise and lengthwise. It uses 430 ma rapid-start lamps. Units are offered in 4-ft lengths for 2-, 3- and 4-lamps. Also a 4-lamp, 8-ft tandem luminaire arrangement is available.

Lighting Products Inc., Highland Park, Ill.

Outlet (39)

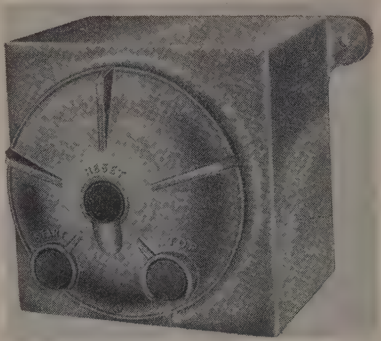
A new single 3-wire grounding outlet, No. 5351, for use on 20-amp appliance circuits has been introduced. Rated at 20-amp, 125-volt, it features two green hex grounding screws which permit feed-through of grounding conductors. Contoured design of outlet face permits insertion of cap blades. Heavy barriers separate contacts of opposite polarity and grounding contacts. Designed for side wiring only, outlet has washer-type plaster ears. It also may be used with 15-amp, 125-volt grounding caps or regular ungrounded parallel blade caps.

Pass & Seymour, Inc., Syracuse, N. Y.

Motors (40)

Three models of low voltage dc motors in frame size No. 4636 are available for general use and may be obtained with or without radio suppression. Winding designs offered are shunt, compound or series type. Typical ratings for this frame size are: ⅙ hp, 3500 rpm, 12 or 24 volts dc; ¼ hp, 2100 rpm, 12 or 24 volts dc; and ⅓ hp, 3600 rpm, 24 volts dc. Each of the motors has a 5½ in. frame diameter and weighs approximately 14.5 lbs. Motors are built in totally-enclosed non-ventilated or totally-enclosed fan-cooled cast aluminum housings and are equipped with ball bearings.

Universal Motor Div., Robbins & Myers, Inc., Springfield, Ohio



Motor Starter (41)

An all-aluminum housing for size 0 and size 1 magnetic motor starters has been announced. GMSM series can be used in both hazardous and non-hazardous locations (NEMA 3, 3-R, 4, 5, 7 and 9) and is adaptable to custom hub arrangements. Housings are furnished with front operation for start-stop and reset buttons, or with reset button only.

Killark Electric Mfg. Co., Vandeventer and Easton Aves., St. Louis 13, Mo.

Lighting Systems (42)

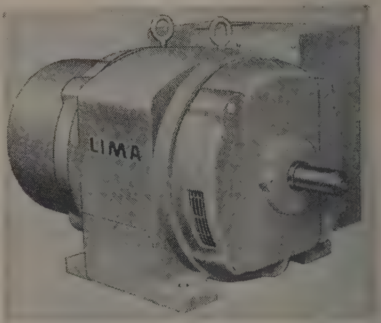
Portable lighting systems for quick on-job assembly in construction and repair work. Plug-in, building block units for the 2-, 3-, and 4-pole "Tuffline" systems include primary and secondary breaker panels, distribution blocks, and light streamers with complete electrical and safety protection. Equipment and cables are insulated with a neoprene compound. Plug and receptacle connections are polarized to prevent mismating and are designed to keep water out of connections even when submerged. Systems, which can distribute power for tools as well as for lighting, can be set up and taken down without tools and moved or expanded as a job progresses.

J. B. Nottingham & Co., Inc., 441 Lexington Ave., New York 17, N. Y.

Controls (43)

A new line of fan and limit controls, designed to meet the current needs of the central heating industry. All include switches and are equipped with "color-coded" switch guards for identification. Switches have a rating of ¾ hp, and are enclosed in controls with a moulded, nonconductive covering. Fixed fan and limit settings are also available in controls. Tabs are provided to secure levers at a preselected setting. A manual summer fan switch, which can be installed at factory or added in field, is also available.

Robertshaw-Fulton's Grayson Controls Div., Long Beach, Calif.

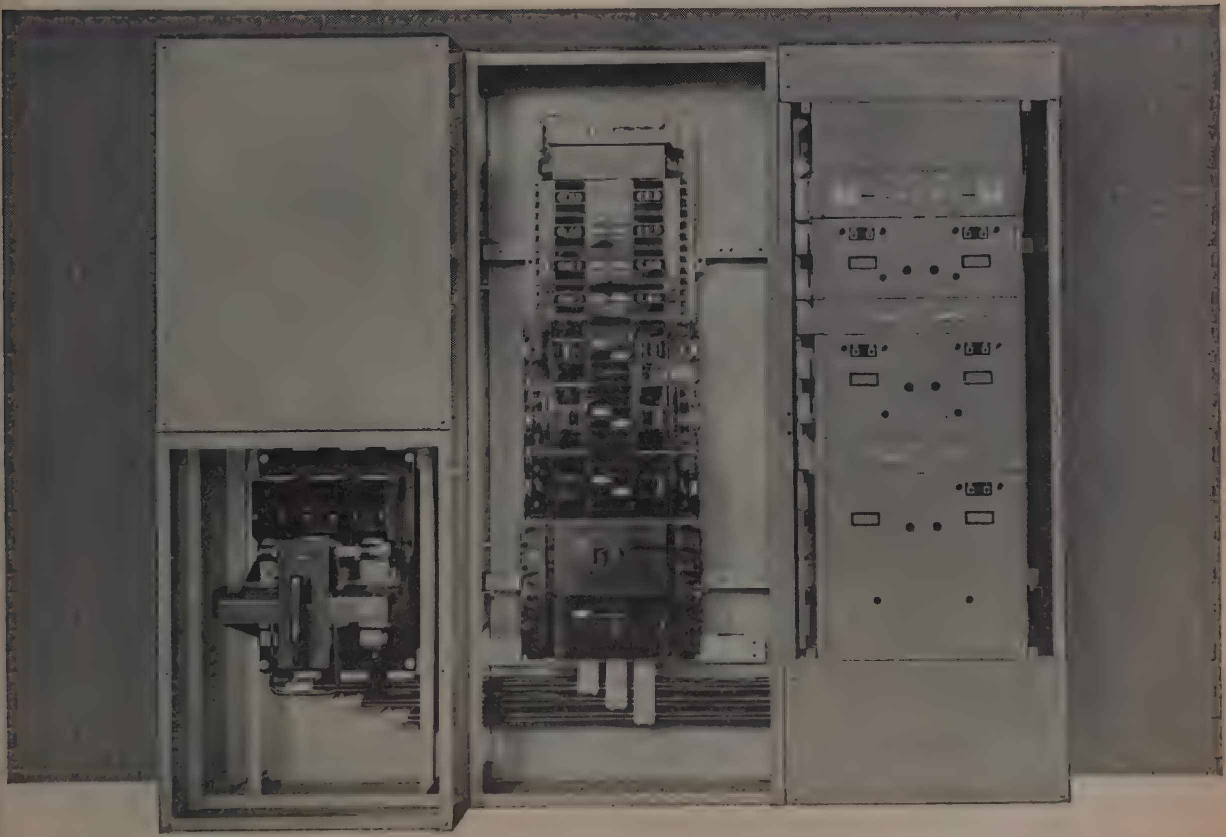


Generators (44)

A new line of "Precise Power" and "Special Brushless" ac generators and motor generators has been announced. "Precise Power" are available in ratings from 5 kw through 100 kw in open-type construction with static exciter-regulators. Inherent regulation to plus or minus 10%, or magnetic amplifier regulation to plus or minus 1%. "Special Brushless" ac generators with dripproof construction are adaptable for engine mount or direct coupling to driving motor. Synchronous generators, rated from 5 kw at 1800 rpm through 100 kw at 1800 rpm are equipped with inherent regulation with no external controls.

Lima Electric Motor Co., Inc., Lima, Ohio.

NEW, COMPACT WESTINGHOUSE SERIES 1 BUILDING-TYPE DISTRIBUTION SWITCHBOARDS



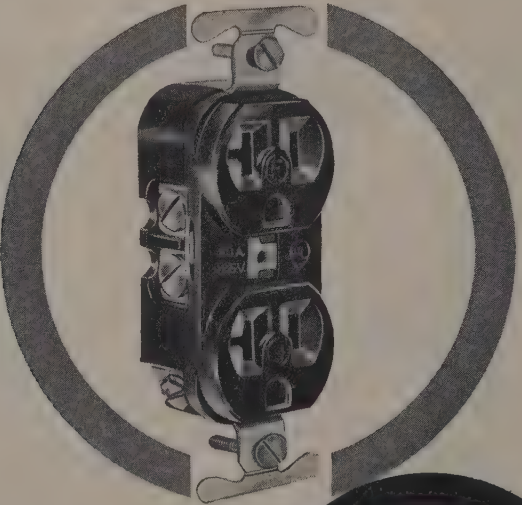
COMPLETELY ACCESSIBLE FROM THE FRONT

Designed for commercial buildings, Series 1 has been standardized for flexibility and low installed cost. Adequate wiring space has been reserved at top and bottom of each structure for incoming and outgoing cables. Series 1 may be installed against any wall where floor space is at a premium, since all components are accessible from the front. Additional distribution sections may be added later as dictated by increasing loads. Each distribution section measures only 15 inches deep. All sections are attractively designed and finished in gray lacquer to provide a pleasing appearance.

For more details and layout information, contact our sales office near you or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. Ask for Publication SA-8667. J-93554

YOU CAN BE SURE...IF IT'S Westinghouse

NEW CIRCLE F 20-AMP "U"-GROUND DEVICES



. . . Section 220-3 (b) of the 1959 National Electrical Code states . . .

"For the small appliance load in kitchen, laundry, pantry, dining room and breakfast room of dwelling occupancies, (1) 2 or more 20-ampere branch circuits in addition to the branch circuits specified in paragraph 220-3 (a) shall be provided for all receptacle outlets (other than outlets for clocks) in these rooms, and such circuits shall have no other outlets."

Designed to provide full compliance with the revised Code, Circle F's *new* No. 2532 does much more! It becomes a "universal" outlet! It accommodates appliances, heavy-duty portable tools, business machines, etc., having substantial energy requirements, where the new 20 A.-125 V. plug cap (No. 2528) is necessary. It also accommodates 15 A.-125 V. 3 wire U-ground and standard parallel blade caps. One outlet for all! Circle F's quality is tops and the price is right. Contact your Circle F representative for complete details.

CIRCLE F MFG. CO.
TRENTON 4, NEW JERSEY

Connectors (45)

Two new 90 angle flex-steel no screw conduit connectors are available. Cat. No. 305—⅜ in. and Cat. No. 306—½ in. are with hinged snap-caps. They twist into the Flex and one extra twist locks them in place. To pull wires through, just flip cap open, pull wires, snap cap shut.

Tomic Sales & Engineering Corporation, 20000 Sherwood Ave., Detroit, Mich.

Heater-Ventilator (46)

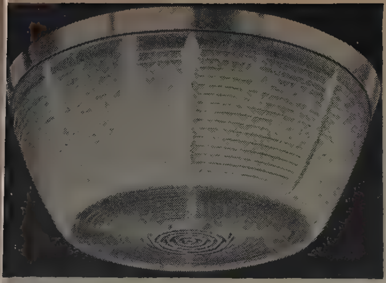
New wall heater-ventilator combination, called Heat-A-Vent, which may be operated simultaneously or separately for use in bathrooms, dens, rathskellars or other rooms where extra heat and moisture removal are desired. A wall light switch controls ventilator where local codes require this type of operation. Two radiant-type heating elements, totaling 1600 watts, provide instant warmth. Unit may be wired to either 120 or 240 volts, 3-wire service.

NuTone, Inc., Madison & Red Bank Roads, Cincinnati 27, Ohio

Adjustable Roller Arm (47)

A new roller arm which can be adjusted to any length between 1 and 4 in. is now available for Type AW limit switches. Arm length can be changed by loosening an Allen head screw and sliding arm up or down to desired position. A scale on one side of arm is marked in ⅛-in. increments for adjustment. Roller can be turned to inside or outside of arm for varied cam track locations, and roller diameters of ⅝ and 1 in. are available.

Square D Company, 4041 N. Richards St., Milwaukee 12, Wis.



Lighting Fixture (48)

A new line of high-intensity, prismatic, ceiling-drum fixtures suitable for use where high foot-candle levels are required. Called "Crodrum," lights are available in 150-, 200- and 300-watt units. Tapered sides of ceiling pan, with ¾ in. of metal showing, blend into tapered sides of drum. They are approved by UL. Data folder 61-B is available.

Perfeclite Company, 1457 *East* 40*th St., Cleveland* 3, *Ohio*

Attic Fan (49)

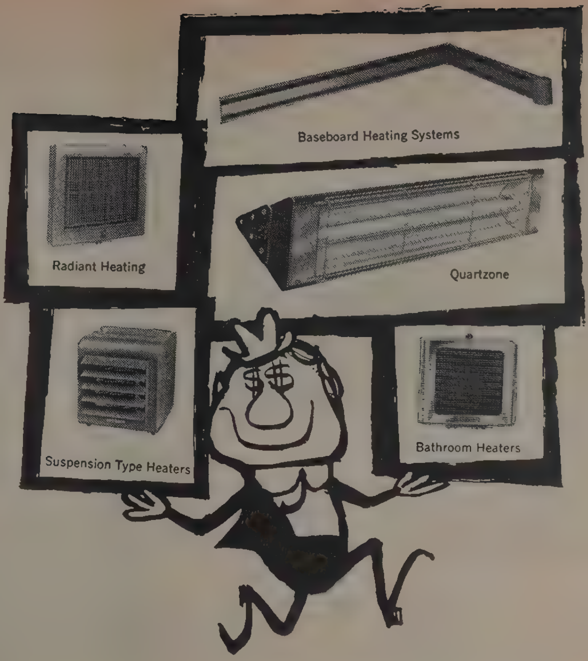
New 30-in. direct drive attic fan uses ¼-hp permanent split-capacitor 8-pole motor. It is designed to operate smoothly at 835 rpm. Features include: full venturi to improve static pressure performance; protective baked enamel finish; steel blades; and extra-large junction box. Ceiling shutters that open and close automatically with operation of fan are available for use with this unit. They feature special "flutter-proof" design, overlapping aluminum louvers mounted in formed steel frame, and fusible link for safety. Entire shutter unit can be mounted in ceiling.

Emerson Electric Mfg. Co., 8100 *Florissant Ave., St. Louis* 36, *Mo.*

Floodlight (50)

Type MVA-14 400-watt mercury vapor floodlight reduces maintenance costs in lighting areas such as service stations. Heat-resisting glass lenses of five types are available. Fixture takes standard type BT-37 clear, color-improved, or color-modified mercury lamps. A hood may be furnished to cut off light. Different types of mounting bases are available, and mercury lamp ballasts as required can be furnished with floodlight.

Crouse-Hinds Company, Syracuse 1, *N. Y.*



It's easy to make a good profit in electric heating when you sell ELECTROMODE

The price is right . . . the mark-up is good . . . installation is quick and easy . . . service calls are virtually non-existent . . . and the name is one that commands respect.

Only Electromode offers you a complete line of electric heating equipment . . . for the home, for the office and shop, for industry.

With Electromode you can offer your customers forced-air heating for a bathroom or a warehouse...complete, baseboard heating systems . . . radiant heating . . . explosion-proof heaters . . . even infrared heating for outdoor locations.

A High Wattage Promotion Campaign

To help you sell profitable home heating installations, Electromode offers a complete promotion package that's guaranteed to make the electrical heating system you install the talk of the town . . . a complete package which you can offer to the building contractor . . . to win you the heating contract.

Electromode Means Quality

Electromode is a name that has stood for the best in electrical heating since 1929 . . . because Electromode has manufactured *only* electrical heating equipment.

The Electromode Safety Grid is a feature that is known and recognized wherever electrical heating equipment is sold. Because all current-carrying, heat-emitting wires are buried in the solid cast-aluminum grid the heating element can't shock, burn or cause a fire.

Write for complete information

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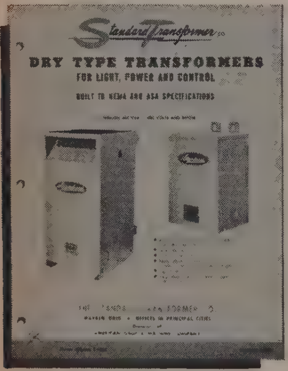
Dept. EC-80, Division of Commercial Controls Corporation
ROCHESTER 3, NEW YORK

NEW BULLETIN FREE . . .
Gives weights, sizes and performance features of Standard's dry type line.



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FOR LIGHT, POWER AND CONTROL
BUILT TO NEMA AND ASA SPECIFICATIONS

Standard dry type transformers for light, power and control are designed for service wherever equipment is required in hazardous areas. Most major oil companies use them. Standard's compound fills the entire case, hardens and seals out lint, dust and dirt. They cut noise levels, improve regulation, reduce temperature rise and are lighter in weight and smaller in size.

Get the facts today from your nearby Standard representative or write directly to us.

Standard Transformer Co.

EXpress 2-1563 • WARREN, OHIO
"WHEREVER THERE IS POWER"

Product Briefs

(51) "Smoothie" **wall plates** moulded of non-combustible, non-absorbing thermosetting plastic have been announced by Circle F. Manufacturing Co., Trenton, N. J. . . .(52) C & S Products Co., Windsor Locks, Conn., has introduced Semper-Seal, a new **epoxy-type resin** for use in splicing and plugging signal, communication, and electrical power cables. . . . (53) A new, improved **fibre conduit**, known as Klean-Kote, has been introduced by the Orangeburg Manufacturing Co., Div. of The Flintkote Co., New York, N. Y.

(54) The Tankit Co., Inc., Newark, N. J., has announced a new electrical contact **cleaner and burnisher** for all electronic equipment, called Liquid Burnisher. . . . (55) Telephone **cabinets** in two types and 19 sizes have been added as standard stock items to the line of wiring installation equipment produced by Keystone Mfg. Co., Warren, Mich.

(56) Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill., has introduced a new adjustable industrial pulse **switch** designed for industrial applications. . . . (57) An industrial-type **battery** has been developed for light-duty industrial trucks, personnel carriers and other small electrically powered utility buggies by the Exide Industrial Div., The Electric Storage Battery Co., Philadelphia, Pa.

(58) Sherman and Reilly, Inc., Chattanooga, Tenn., has introduced Model MH-303 spacer type aerial **cable** stringing block which can easily be changed in the field for stringing either the diamond or inverted wye configurations. . . . (59) An inventory of Rayescent electroluminescent **lighting panels** for commercial applications in sizes from 2 by 2 in. to 24 by 24 in. is now being maintained by the Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.

(60) Westinghouse Lamp Division, Bloomfield, N. J., has announced a broad line of electroluminescent **indicator lamps** for the display of luminous letters or numerals in various types of dials and indicators. . . . (61) Permacel PA 1042 **fixture mount**, a new concept in mounting fixtures and other items to walls and ceilings, has been developed by Permacel, New Brunswick, N. J.

Catalogs & Bulletins

(62) UNIT HEATERS designed for electric heating of schools, hospitals, churches, stores, etc., in free-standing, wall-mounted, or ceiling-mounted styles rated 2.4 through 30 kw are described in Bull. F21100, 8 pages. Edwin L. Wiegand Co.

(63) CEILING SYSTEM of suspended metal leaves arranged to form a continuous colored wall-to-wall pattern beneath banks of fluorescent lamps is covered in 6-page brochure. Luminous Ceilings Inc.

(64) LIGHTING DESIGN. 24-page booklet, "Comfort Conditioning with Light and Air," describes combination lighting fixtures and air diffusers, with step-by-step application instructions and many tables of design data. Day-Brite Lighting, Inc. and Barber-Colman Co.

(65) TIMERS. Complete product line is described in 30-page Catalog D-31, covering latest timing components and linear measuring systems for industrial and military users. Automatic Timing & Controls, Inc.

(66) CEILING LUMINAIRE. 4-page brochure describes hung lighting panel with photos of typical application and installation diagrams. Duffusa-Lite Co.

(67) MACHINERY MOUNTS for stopping vibration, shock, and noise transmission are described in 6-page Bulletin K3C. Korfund Co. Inc.

(68) ELECTRICAL CONNECTORS. 30-page catalog introduces new line of Bronco-Grip cable connectors. Western Insulated Wire Co.

(69) CONTROLS and accessories. Catalog 57-S7, 16 pages, covers break-glass switches, relay panel for gas valve, engine generator isolating switches, marine duty transfer switches, and phase sequence correctors. Automatic Switch Co.

(70) LIGHT LEASING. New 4-page brochure gives details of Lease-Light Plan permitting owners or tenants in the U. S. or Canada to rent or time-pay lighting modernization or new construction, thus freeing working capital for other uses. Smithcraft Corp.

(71) SURFACE RACEWAY. Revised 152-page catalog No. 22 covers complete line of surface metal raceways and fittings, multi-outlet assemblies, and lighting equipment. Wiremold Co.

BISHOP
tapes
sealing
splicing
jacketing
insulating
BI-SEAL
electrical tape
No. 125 Electrical Filler Tape
Electrical Jacketing Tape
No. 30 High Voltage Splicing Tape
MORE THAN A CENTURY OF ELECTRICAL INSULATION
BISHOP

The most complete line for splicing plastic and rubber insulated cables

. . . for splicing polyethylene insulated cable

BI-SEAL Self-Bonding (polyethylene base) Electrical Tape is particularly recommended as the primary insulation for low and high voltage polyethylene insulated wires and cables. Extremely low water absorption . . . low power factor . . . low dielectric constant. Operating temperature to 85°C.

. . . for general insulating and jacketing

VINYL Electrical Tape No. 1 & No. 2, .007" and .010" thick, offers complete electrical and mechanical protection for most taping problems . . . Improved method of bonding adhesive prevents transfer, gives greater strength . . . For better looking, more compact splices.

. . . for rapid insulation build-up

No. 125 Electrical Filler Tape, ⅛" thick, fuses into a solid mass of high-dielectric insulation in a matter of seconds. This insulating compound in tape form is ideal for cable splice build-up, padding and cable end-sealing.

. . . for permanent cable jacketing

BI-PRENE Electrical Jacketing (neoprene) Tape protects cable splices wherever oil, gasoline, grease, etc., threaten cable life . . . Particularly for neoprene-sheathed cable . . . Forms a permanent outer sheath.

. . . for high voltage cable splicing

No. 30 High Voltage Splicing Tape is recommended for splicing cables insulated with ozone-resistant rubber compounds and operating in excess of 2000 volts. This butyl-base tape handles exceptionally well in cold weather.

NEW "NEOFIL" (neoprene) Electrical Filler Tape. A ⅛" thick neoprene compound in handy tape form — for low voltage use. Insulates in one wrap! No covering tape needed!

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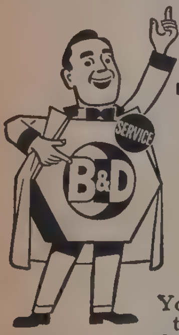

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50th YEAR

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Quality Tool Service

(72) ELECTRICAL TAPE. New 12-page booklet, "Useful Tips for Top Savings and Service," covers 24 specific tape jobs to help in selection of most practical and economical tape for any given job. Johns-Manville, Dutch Brand Div.

(73) LINEAR WALL LIGHTING with open top and bottom, thus illuminating both wall and ceiling areas, is covered in new brochure No. FL-1. Prescolite Mfg. Corp.

(74) PLUG-IN BUS DUCT application data is presented in 28-page booklet No. 30-661, including all drawings and specifications needed to lay out, specify and install the equipment. Westinghouse Electric Corp.

(75) BATTERIES. Technical data sheets give electrical, physical, environmental and typical application characteristics of automatically activated primary silver-zinc batteries. Yardney Electric Corp.

(76) MASONRY ANCHORS. Two-color 18- by 20-in. wall chart pictures principal types of anchors and drills and indicates where each should be used. Rawlplug Co., Inc.

(77) AC MOTORS. Pricing and dimensional data on Multi-Shielded motors from ¼ to 200 hp are given in new 56-page catalog. Sterling Electric Motors, Inc.

(78) ALTERNATORS and converters. Bulletin 515-A, 4 pages, covers nine basic models of alternators ranging from 1 to 7.5 kva and producing 360 to 3300 cycles, and two types of converters from 2.5 to 10 kw, 120 to 420 cycles. Robbins & Myers, Inc.

(79) HOME LIGHTING handbook, 36 pages, presents ideas intended to show the inter-relationship of today's decor and modern lighting design. Progress Mfg. Co., Inc.

(80) TWO-WAY RADIO equipment available for business communication is covered by 24-page Bulletin ECR-497B, describing frequency allocations, amplifiers, microphones, remote control, and antennas. General Electric Co.

(81) PLASTIC CONDUIT is described in 20-page catalog, with comprehensive test results, installation instructions, and specifications. Kraloy Plastic Pipe Co., Inc.

(82) WEATHERPROOF EQUIPMENT including power outlets, mobile home outlets, pole top switches, remote control switches, terminal boxes, junction boxes, and wire trough are described in 10-page Bulletin 22. Hoffman Engineering Corp.

(83) LIGHTING FIXTURES for commercial and residential use including chandeliers, pendant fixtures and wall fixtures are covered in 64-page Catalog. A. Heifetz Co.

(84) MOTORS AND GENERATORS, gearmotors, speed reducers, motor-generators, and frequency changers are described in Bulletin L-1661A, 8 pages. Howell Electric Motors Co.

(85) LIGHTING FIXTURES. 4-page brochure describes three new fixture series: the Sun 'N Sand, Florentine, and Planter. Virden Lighting Div., John C. Virden Co.

(86) STREET LIGHTING. Engineering specification brochure, Catalog ALS-5, covers detailed data on lighting standards. 16 pages. Pfaff and Kendall.

(87) CABLE REELS, lifters, wire meters and measurers, and joist borers are described in 4-page price sheet. Hykon Mfg. Co.

(88) SWITCHGEAR PROTECTION. Bulletin 6020, 8 pages, covers Fusematic coordinated combination of power circuit breakers and current-limiting fuses for feeder systems in the 600-volt class. Federal Pacific Electric Co.

(89) BATTERIES in Plastrite jars for stationary lighting and power applications are described in 12-page brochure giving discharge characteristics, engineering specifications, and dimensional data. Gould-National Batteries, Inc.

(90) STREET LIGHTING. Bulletin GEA-7100, 28 pages, provides layouts, specifications, and application data for entire street-lighting systems. General Electric Co.

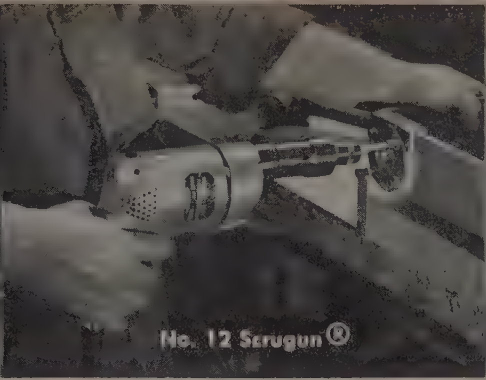
(91) CELLULAR FLOOR and roof decks of concrete providing network of wiring raceways in new University of Houston building are described in 6-page folder. Flexicore Co. Inc.

(92) DC POWER SUPPLIES. Silicon units with magnetic amplifier control and rated from 100 to 1500 amps, 14 to 36 volts, are described in 2-page Bulletin SE-102. Sprague Engineering Corp.

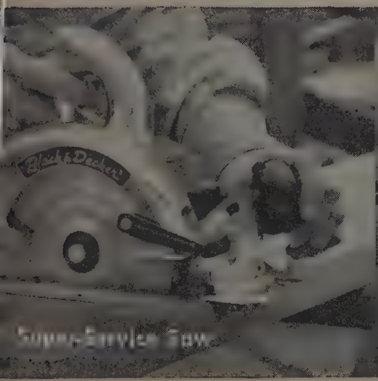
(93) LIGHTING FIXTURES. New brochure describes a pulldown, accent light, bath bracket, and entranceway or patio light, plus a post light photoelectric control collar. Thomas Industries Inc.

(94) SOLDERING TOOLS. Cat. VG-250 covers prices, descriptions, and illustrations of soldering irons, pencils, tool holders, and solder pots. Vulcan Electric Co.

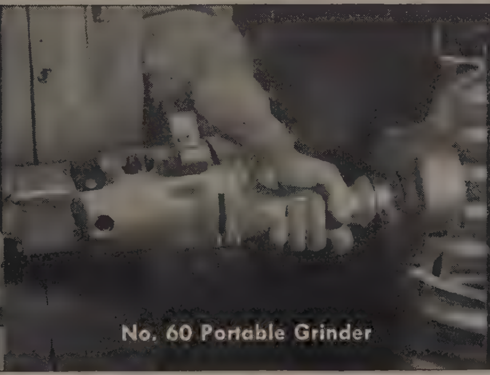
RODUCTION...CONSTRUCTION...MAINTENANCE

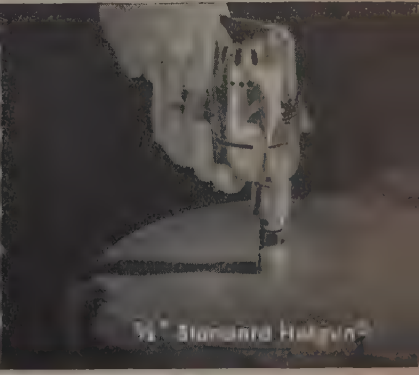


vhether the job's drilling, sanding, sawing,



or any other tool job, you'll find that





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Here is the 1960 edition of the Klein catalog illustrating and describing the complete line of Klein tools and equipment for electricians.

It contains many new additions to the Klein line—including Replaceable Gaff Climbers, a newly developed Hot Line Grip and an even wider range of pliers for every purpose.

The Klein Catalog 103 will be of interest to linemen, electricians —good workmen everywhere.

Write for yours.

Foreign Distributor: International Standard Electric Corp., New York.

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7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

(95) Lightning Arresters for protection of power circuits of any kva capacity are described in 4-page brochure including prices, dimensions, and characteristics. H. K. Porter Co. Inc.

(96) DC Contactors and relays. Bulletin GEA-6621A, 32 pages, uses diagrams, application data, and specifications to describe complete line for industrial dc control. General Electric Co.

(97) Air Switch. 4-page brochure describes high-voltage vertical-break Type MK-40 linkless, leverless, and braidless power switch. H. K. Porter Co. Inc.

(98) Time Switches for automatic control of swimming pool equipment. Bulletin NR-80, 4 pages, describes time control of filtration, lighting, water heating, chlorination, and alarms. International Register Co.

(99) Electric Eyes. Bulletin 577 describes photoelectric applications in automation and general industry, with characteristics and data on specific equipment. Photomation, Inc.

(100) Trencher. Bulletin L-108, 12 pages, covers Model 92 unit for digging trenches 10 to 20 in. wide down to 5 ft deep for such applications as highway, airport, and railroad cable. Cleveland Trencher Co.

(101) Steel Shelving for such commercial and industrial uses as storage, shelving and cabinets, truck shelving, and bins is described in Catalog 2400, 36 pages. Penco Div., Alan Wood Steel Co.

(102) Ballasts for mercury lamps. Bulletin GEA-7056, 10 pages, contains prices, dimensions, wiring diagrams, and other data for selecting and applying standard and special-purpose ballasts. General Electric Co.

(103) Closed-Circuit TV—What every businessman should know. 9-page illustrated brochure explains industrial and commercial TV in layman's language, covering basic application such as hazardous viewing and bank administration. General Precision, Inc.

(104) Valves. Bulletin 91024, 20 pages, describes 2-, 3-, and 4-way electrically operated valves, with complete specifications. Airmatic Valve, Inc.

(105) AC Motors from 1/100 to 1/3 hp designed for quiet running in small areas are covered in 8-page Bulletin 445. Robbins & Myers Inc.

(106) Master TV Systems—design and installation. 24-page book gives application details and servicing data for systems suitable for all types of occupancies. Blonder-Tongue Laboratories, Inc.

(107) Electrical Tape. New 4-page booklet tells how plastic electrical tape cut down-time due to electrical failures in the plant of Studebaker-Packard. Johns-Manville, Dutch Brand Div.

(108) Test Instruments. New Bulletin 19-60-6 digests complete line of Meggers, resistance testers, dielectric test sets, cable fault locating equipment, and others. James G. Biddle Co.

(109) Switches. 48-page Catalog 6002 covers complete line of enclosed safety switches, service entrance equipment, branch circuit panels and meter sockets. General Switch Co.

(110) Technical Data. 1960 catalog lists available pocket-size Technical Data books for every field of engineering, useful to engineers, tradesmen, and students. Lefax Publishers.

(111) Power Fuses. Bulletin 261 describes SMD fuses for 34.5- to 138-kv power transformer primaries, potential transformers, and sectionalizing use. 24 pages. S&C Electric Co.

(112) Pilot Light digest gives 24 pages of condensed technical data on pilot light assemblies, lamps and accessories. Dialight Corp.

(113) Thermostats for electric heating. Bulletin R55100, 4 pages, illustrates and describes complete line of thermostats for controlling electric heaters in residential, commercial and industrial applications. Edwin L. Wiegand Co.

(114) Recessed Fixtures. Calculite incandescent lighting is described in 36-page booklet with construction drawings and calculator charts. Lightolier.

(115) Panel Meters. Bulletin GEA-7034, 12 pages, gives complete description and buying information on 2½-, 3½- and 4½-in. meters. General Electric Co.

(116) Transformers for luminous tube applications. Hermetically sealed weatherproof units are covered in new catalog. Jefferson Electric Co.

(117) Heating Controls. Bulletin 1508-AG includes new Click Dial wall thermostat and low-voltage

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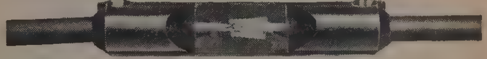

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thermostats for electric heating in addition to standard line. Penn Controls Inc.

(118) PANELBOARDS, meter socket panels, and circuit breakers are described and illustrated with complete specifications in new 45-page pocket-sized Handi-Log. Cutler-Hammer.

(119) STUD DRIVING systems. New brochure N-160 covers guns, studs and accessories for anchoring wood or metal to concrete or steel. Gregory Industries Inc.

(120) VAPORTIGHT LIGHTING fixtures of aluminum for industrial use. Bulletin 1099-60, 4 pages, gives complete specifications. Steber Mfg. Co.

(121) FIRE ALARMS. Five fully supervised systems with or without coded stations are described in new brochure. Wheelock Signals Inc.

(122) EXPLOSION-PROOF FITTINGS for hazardous locations of all-aluminum construction are covered in new catalog which includes dimensional drawings and illustrations. Killark Electric Mfg. Co.

(123) HI-HAT LIGHTING fixtures. Wall chart shows how to achieve 16 different finished lighting fixtures from four basic round housings. Markstone Mfg. Co.

(124) RESISTORS, rheostats and potentiometers for power applications are covered in Catalog 260, 8 pages. Hardwick Hindle, Inc.

(125) MINIATURE LAMPS. Pocket-sized booklet lists all known standard miniature lamps with sources of supply, drawings of lamp styles, and descriptions of parts. Chicago Miniature Lamp Works.

(126) ANNUNCIATORS. Bulletin A-200, 24 pages, describes line of flexible, modular, industrial lamp annunciator systems for use in factories, power plants, and process control. Edwards Co. Inc.

New Books & Pamphlets

NEMA Standards available from National Electrical Manufacturers Assn., 155 E. 44th St., New York 17, N. Y.:
CP 1-1960: Shunt Capacitors, 50¢.
HU 1-1960: Industrial Heating Units and Devices, 30¢.
SG 6-1960: Power Switching Equipment, $3.00.
TR 17-1960: Arc Furnace Transformers (Also FEMA and AIEE Standard), 70¢.

UPPER MICHIGAN contractors Leonard Brawley, Edison Sault Electric Co., and David Somes, Somes Electric Co., both of Sault St. Marie, Mich., tell F. E Keith, Keith Electric Co., Des Moines, Ia., of their success in selling electric space heating in a 10,000 degree-day area. They met at NEMA Electric House Heating Symposium in Chicago.

Compilation of ASTM Standards, Metallic Electrical Conductors, B-1, 368 pages, $4.50. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

This volume contains all standards published by ASTM concerning electrical conductor efficiency and cable design. Completely new standards included are for bare aluminum wire, aluminum-coated steel core wire, and the testing of electrical conductivity by use of eddy currents.

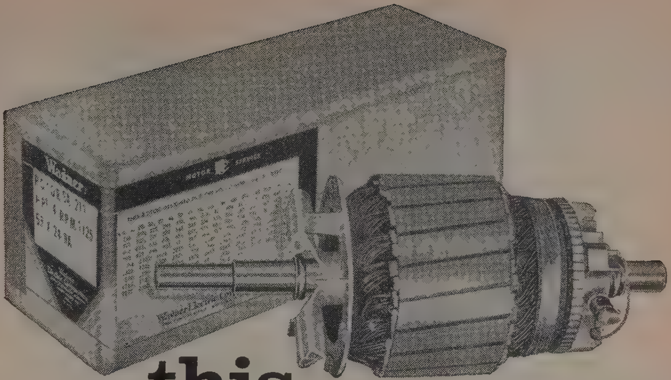
Compilation of Standards, Rubber Products, D-11, 1052 pages, $9.75. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

This 19th Edition includes 163 standards, 22 of which are new. Topics covered include electrical protective equipment, insulated wire and cable, and tape.

Mineral Wool Insulation and the All-Weather Comfort Standard, 10¢. National Mineral Wool Assn., 1270 Sixth Ave., New York 20, N. Y.

Developed for electrically heated and air-conditioned houses by a group of electric utilities and manufacturers of cooling and heating equipment, insulation, and glass, this booklet sets forth new performance standards for house insulating materials. R-factors are explained which have been established to meet the heat-loss requirements of the all-weather comfort standard.

Proceedings of the Fifth Conference on Magnetism and Magnetic Materials. 410 pages, $10.00. McGraw-Hill Book Co., 327 W. 41st St., New York 36, N. Y.



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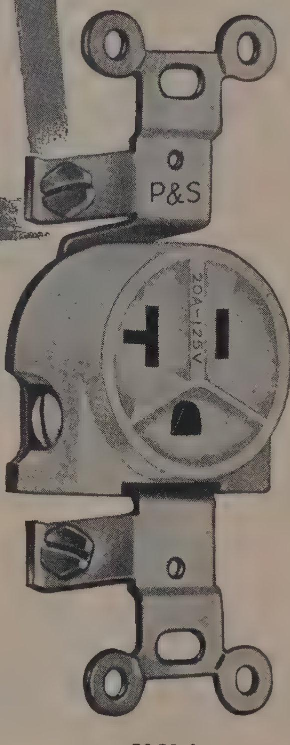

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Features:

- Two easily accessible green, hexagonal grounding screws permit feed-through of grounding conductors.
- All contacts, including grounding contact, are of double grip type.
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HIGHER LIGHTING INTENSITIES, steadily mounting and now receiving vigorous impetus as a result of the recently-published Blackwell Report, were discussed at EMEA's spring lighting conference by George J. Taylor, past-president of the IES (right) who is pictured here with Urban Beh, consulting lighting engineer and general chairman of the Conference.

Important recent developments in the field of magnetism and magnetic materials, reflecting work being done on magnetism and magnetic materials in physics, chemistry, and other areas. Topics presented vary from relatively simple test techniques for evaluation of materials to sophisticated theoretical studies.

Techniques of Plant Maintenance & Engineering—1960, 341 pages, $10.00. Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

A report of the latest Plant Maintenance & Engineering Conference. Answers to 2000 questions plus the texts of 34 papers reveal the approach by industry to keeping plants and machinery running at optimum efficiency, the advance of automation from research and experiment to reality, and the significance of automation in maintenance operations.

Tube Substitution Handbook, Cat. No. TUB-1, 96 pages, $1.50. Technical Book Div., Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Ind.

A complete and authoritative reference listing over 3800 receiving and industrial tube direct substitutions, including European-for-American substitutions. Useful to the technician or maintenance man servicing electronic equipment.

Lighting Price and Data Book, available through subscription only at quarterly fee of $12.00. National Price Service, Henderson-Hazel Corp., 13635 Euclid Ave., Cleveland 12, Ohio.

Devoted exclusively to lighting

equipment, this book provides accurate lighting equipment prices and data for use in estimating, specifying, buying, and selling. Listings are restricted primarily to brands distributed nationally and to commercial and industrial types of lighting equipment, including fluorescent and incandescent fixtures, floodlighting and accessory equipment.

Footcandle Levels and Interior Lighting Design. 60 pages, 10¢. Westinghouse Electric Corp., P.O. Box 388, Bloomfield, N. J.

Pocket-size manual includes recommended footcandles for industrial, commercial and residential applications, information on distribution and light measurements, precalculated footcandle tables, information on coefficients of utilization and maintenance factors, and data on fluorescent, incandescent and mercury vapor lamps and ballasts.

Selected Semiconductor Circuits Handbook, edited by Seymour Schwartz; 506 pages; $12.00. John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y.

Over 150 usable semiconductor circuits—both computer and communication types—together with a discussion of applicable general theory are presented. All component values are given. Covered in this manner are direct-coupled, low-frequency, and high-frequency amplifiers; oscillators, ac to dc power supplies; power converters; and switching circuits.

Servicing Unique Electronic Apparatus, Cat. No. SED-1, by Jack Darr; 128 pages; $2.50. Technical Book Div., Howard W. Sams & Co., Inc., Indianapolis 6, Ind.

Twelve chapters give detailed information for the maintenance man or service technician on troubleshooting and repairing of such apparatus as liquid-flow timers, electric scoreboards, radiofrequency heaters, gas-fired boiler controls, garage-door openers, photoelectric cells, ultrasonic cleaners, and motion-picture sound systems.

Foundations of Electromagnetic Theory, by John R. Reitz and Frederick J. Milford. 387 pages; $8.75. Addison-Wesley Publishing Co., Reading, Mass.

A comprehensive treatment of electrostatics, dielectrics, magnetic fields, and physics of plasmas for the man with a sound background in mathematics.

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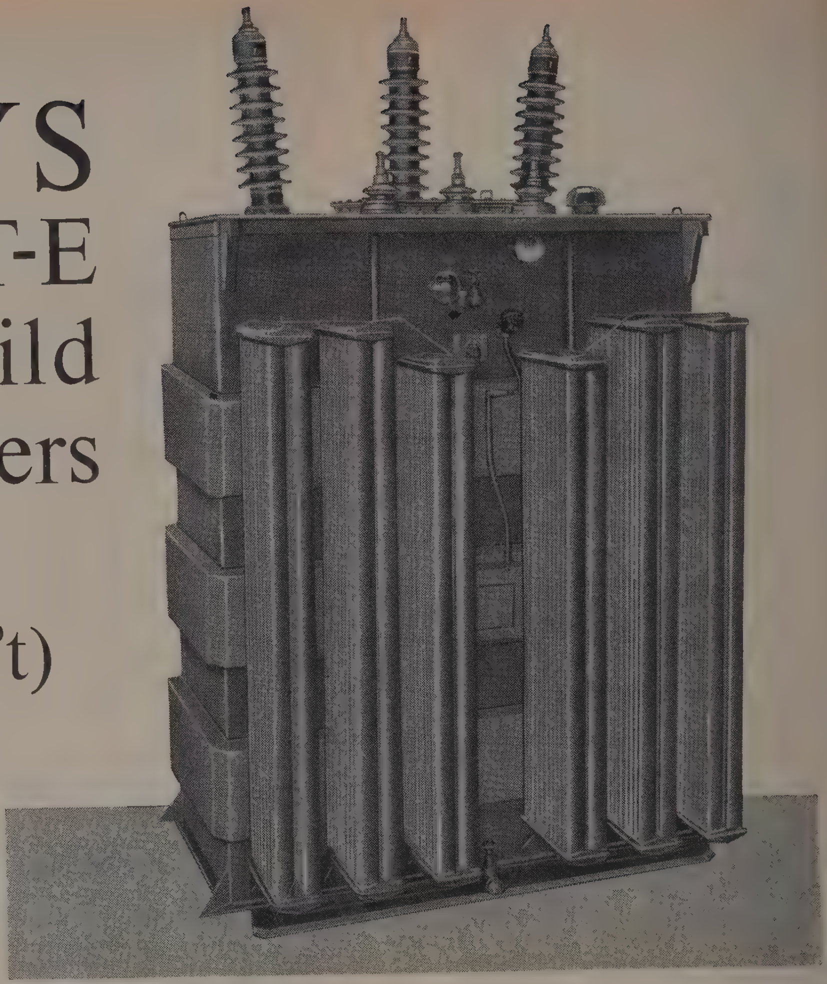
9 WAYS that I-T-E could build transformers cheaper (but doesn't)



1. Use cheaper core materials. Losses would be higher or the transformers would be heavier. I-T-E continues to use grain-oriented silicon steel for maximum flux density.

2. Reduce the number of coil turns. This would save wire. But the transformers would be noisier, and losses would be higher. Who wants that kind of economy?

3. Skimp on tank construction. Would you want to risk tank leaks or transit damage? I-T-E double-welds seams inside and out . . . uses heavy gage metal that stands up.

4. Use substitute insulation. We could give it a fancy trade name and present it as new. I-T-E uses only time-proven materials—to insure longest transformer life.

5. Reduce or eliminate coil bracing. Short circuits can tear transformers apart inside. I-T-E braces them to withstand short circuit stresses.

6. Cheat on winding spacers. What's to keep adjacent turns from touching in case of a short circuit? Only the spacers. Cut down on them, and your transformer is on borrowed time.

7. Wind discontinuous coils. We could quit winding all coils from continuous, unbroken wire. Wind each disc separately and braze together. And hope you never have a short circuit.

8. Use flimsy radiators. Trouble with radiators is they stick out like bat wings. Flimsy construction would cut costs. But damage could suddenly become a big, expensive problem.

9. Cut down on the finish. This would just cost you more in frequent repainting. I-T-E shot blasts inside and out. Applies one prime coat and two finish coats. Keeps rust out.

Bulletin 5802-1A covers I-T-E transformers in detail. Write I-T-E Circuit Breaker Company, Dept. TR, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E

I-T-E CIRCUIT BREAKER COMPANY

Reader's Quiz

QUESTIONS from readers on problems of industrial equipment, installations, maintenance and repairs. Answered by electrical maintenance engineers and industrial electrical contractors out of their experience. For every question and every answer published we pay $5.00.

Ground Detectors

QUESTION A38—In our installation, consisting of a 480-volt, 3-phase ring feeder that has a perimeter of 3000 ft, we recently installed a set of ground detector lamps, using three pilot lamp units, 6-watt, 120-volt, with resistors. These units were correctly wired to the main bus in the phase sequence A-B-C. When a test was made by temporarily grounding each phase, one at a time, through a resistor, there is a 180° reversal in the operation of the lamps. When the two main ring bus breakers are opened, the ground detector operates in normal phase sequence.

We have transposed the wiring so that the phase temporarily grounded shows a bright lamp and the other two are dim. As now connected, can we depend on this connector to correctly show a ground? What is causing it to operate in reverse?—W.F.W.

ANSWER TO A38—Your reader, who poses the mystery of the ground indicator lights, has good reason to be perplexed. The connection of a resistive single-line-to-ground fault will produce a peculiar family of line-to-ground voltages on the three phases. Perhaps of more vital interest is the dangerous pattern of line-to-ground voltages which will result if the fault circuit is an inductive reactance such as a transformer winding or a motor magnet coil.

The peculiar voltage pattern stems from the fact that every "so-called" ungrounded electrical system is unavoidably capacitively grounded. Throughout the system the energized conductors are separated from ground by solid insulation. Each and every element of the system represents a minute capacitor between phase conductor and ground. In the aggregate this can add up to a sizable capacitance, often more than one mfd per phase. In a balanced 3-phase system, the capacitance to ground will be essentially equal on each of the three phases. It is customary to identify the capacitive effect per phase (Co). The normal-frequency capacitive reactance per phase to ground is called Xco. The capacitive reactance to ground of the entire 3-phase system becomes $\frac{1}{3}$ Xco.

Suppose that a 60-cycle 480-volt ungrounded system possesses 1 mfd capacitance to ground per phase. This would fix Xco at $10^6/377(1)$ or 2650 ohms per phase. The combined 3-phase impedance coupling to grounds is $\frac{1}{3}$ Xco or in this instance, 833 ohms.

The problem is covered by Fig. 1. With an equal capacitive reactance Xco between each phase and ground and no fault condition, the three line-to-ground voltages would be identical (277 volts). The connection of a resistor between one phase and ground (say phase A) causes a change in the line-to-ground voltage pattern controlled by the ratio of the fault circuit resistance "R_F" and the system capacitive reactance to ground "$\frac{1}{3}$ Xco." With "R_F" nonexistent (infinite in value) we are at the right-hand extremity of Fig. 1 with all three line-to-ground voltages equal to 277 volts. Through a wide range of the higher values of R_F, the voltage on phase B to ground is less than that of the faulted phase. When R_F becomes lower than $\frac{1}{3}$ Xco, the line-to-ground voltage on phase A becomes lower than the other two. At the left terminal of the figure with $R_F = 0$, the line-to-ground voltage on phase A has dropped to zero and the other two phases have gone to 480 volts to ground. Notice also in Fig. 1 that an intermediate value of R_F (near zero) causes the voltage on phase C to extend beyond 500 volts to ground.

Fig. 2 presents the more dangerous situation associated with an inductive reactance as the fault connection between phase "A" and ground.

The significance of the horizontal scale is the same as that for Fig. 1.

For a wide range of inductive reactance in the fault, dangerously high line-to-ground voltages can be developed on all 3-phase conductors. Perhaps the reader would find it advantageous to investigate the application of system grounding to eliminate these severe overvoltage tendencies of an ungrounded system.

Notice that the breaks in the curves result from a change in the horizontal scale unit—not a discontinuity in the curve itself.—R.H.K.

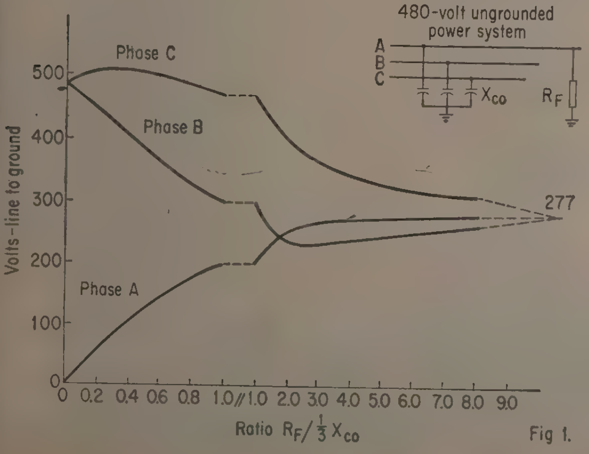


Fig 1.

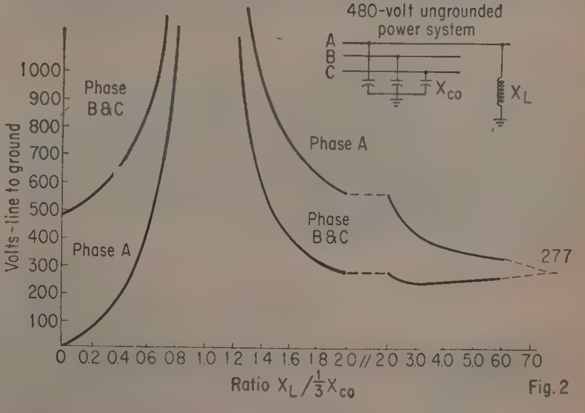


Fig. 2

How Okonite solves your High-Voltage Distribution Problem

Reliable primary distribution is a must for efficient, economical operation. As the use of higher voltages increases, the problems of keeping primary distribution reliable increase too. But, whatever your specific need, Okonite has designed a construction that will do the job . . . like those shown here.

OKOLITE-INSULATED

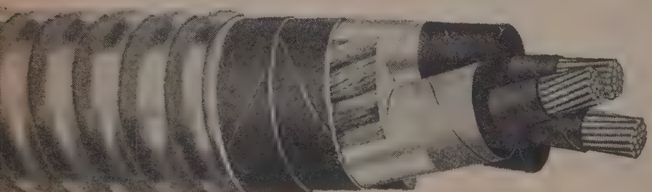
This Okolite-insulated 25kv submarine power cable, installed by Bonneville Power Administration under Puget Sound, was 7½ miles long, weighed ¾ million lbs. It is typical of the many Okolite-insulated cables designed to solve specific high voltage power problems. Other constructions for underground, aerial, duct or interior installation are frequently protected by an Okoprene (neoprene) sheath, compounded to Okonite's own formula for high weather, temperature and abrasion resistance. Okolite oil-base insulation has demonstrated in more than 30 years of service its high dielectric strength, moisture-resistance and stability in all types of installation conditions. All Okolite-insulated cables must withstand self-imposed a-c and d-c voltage tests that are highest in the industry.

OKONEX-OKOPRENE

This Okonex-Okoprene 15kv primary distribution system was installed to save space, eliminate safety problems and provide improved voltage regulation at Magnolia Petroleum's 1500-acre refinery near Beaumont, Texas. Okonex (butyl-base) cables are highly resistant to heat, and are often specified to give additional protection in high ambient parts of the plant or to provide additional ampacity in circuits. The Okoprene sheath provides excellent protection against moisture and corrosion as in Magnolia Petroleum's refinery where there was a high moisture-saline content in the air plus chemical atmospheres at many of the processing units.

SELF-SUPPORTING CABLE

These four 7500-volt Okolite-Okoprene self-supporting aerial cables span 395 feet to distribute power to a section of a Southern paper mill. Easy to install in one simple operation, Okolite-Okoprene self-supporting aerial cable reduces clearance space requirements, is neat-appearing, often may be installed on existing buildings or supports, offers greater safety to personnel and eliminates insulator flashover due to contamination. Okonite's patented Dualay assembly can be tapped hot at any point in non-shielded types.



LOXARMOR

And on any high-voltage construction, a Loxarmor covering offers economy and flexibility in a cable system where the complete protection of a rigid conduit system is not required. Excellent mechanical protection is provided by a Loxarmor interlocking "S" tape available in galvanized steel, aluminum, bronze or copper. Loxarmor saves money in installation and initial purchase costs, makes it easy to add or re-route circuits and requires less space than conduit to handle the same number of circuits.

One of these high-voltage cable constructions will fill your requirements. Write for Bulletin EC-1117, "How to Choose Insulated Cable," to The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, New Jersey.

where there's electrical power . . . there's **OKONITE CABLE**

7090

Motor Insulation Resistance

QUESTION B38—When drying out motors in an oven, occasionally you run across some which will reach maybe 5 megs when hot. Let the motor cool off, and the resistance will go to infinity. Theoretically, the resistance should be highest when hot—should it not?—S.J.P.

ANSWER TO B38—It appears that S.J.P. is trying to compare the insulation resistance, of his motor, to the copper winding resistance.

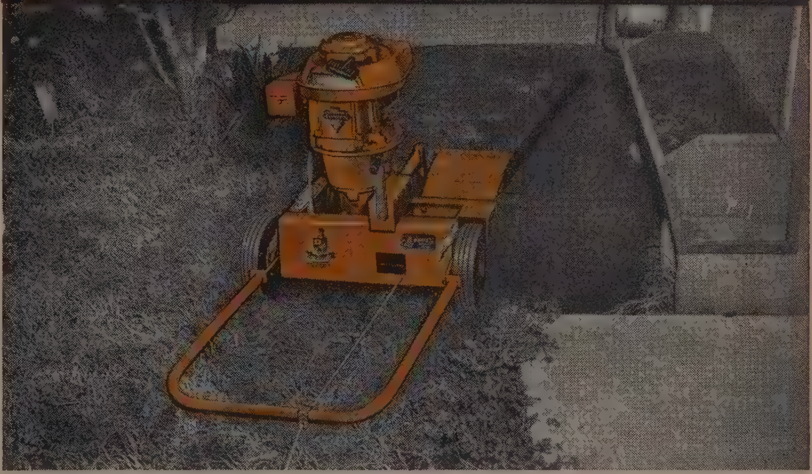
When drying out a motor in an oven, the copper resistance, theoretically, will be at its highest value. However, the insulation resistance will go down, while the insulation materials are in a semi-fluid state.

A 440-volt motor, at room temperature, should have at least 1 megohm insulation resistance. The copper resistance of the stator winding will vary with horsepower. A ½ ohm reading is not uncommon. —H.E.H.

ANSWER TO B38—It is true that the resistance of metal, or in this case copper, increases with temperature rise. However, this rule does not apply in this case because resistance tests are made between the winding and the stator (ground) or between individual windings. As this is the case, you are measuring the resistance of the insulation and not the windings. There are a number of conditions which enter the picture now. Different types of insulation will have different characteristics with temperature changes. There is also the probability of some winding insulations showing some breakdown in resistance as calculated temperatures are exceeded. Although the temperature of the oven is not high enough to cause a breakdown, there still would be some loss of resistance. Another fact that should not be overlooked is the varnish used on the winding. Some types of varnish will become somewhat liquified under oven temperatures and thereby decrease in resistance. There are a number of other conditions of insulation which could enter the picture in your case. However, I think these are sufficient to cover your case.—H.E.R.

ANSWER TO B38—Practically all dielectrics have negative temperature coefficients. That is, unlike copper wire, the resistance of the insulation decreases with rise in

the DAVIS PUP TRENCHER
IS POSITIVELY SELF-PROPELLED



trenches while you do other work!

The portable, self-propelled Davis Pup Trencher has proven itself as the most valuable trenching tool available for assignments from 2″ to 3″ wide to 36″ deep or 4″ wide to 18″ deep. Users have reported it has paid for itself on the very first job.

It is positively driven by a simple, six-speed winch mechanism that pulls it down the line you want dug. Since it doesn't require constant supervision, you are free to take care of other work on the job — such as prepare pipe or cable for the trench. It disturbs a minimum of turf so backfilling is easy.

The Davis Pup has quality features throughout, but it is still priced less than comparable trenchers. Compare it for performance, quality, and price. See if you don't agree that pound for pound, dollar for dollar, it's your best trenching buy!

and if you need to go larger — the NEW DAVIS T-66 fills the bill!

This amazing trencher features positive traction, hydraulic variable speed drive, accurate speed control, hydraulic boom control, pre-loaded shock absorbing boom, and convenient — virtually effortless — operation. Digs 3″ to 4″ wide to 66″ deep or 12″ wide, 30″ deep and varying depths and widths in between. Compact design with 1350 lbs. total weight; only 37″ wide. Has well-designed backfill blade attachment, two-speed drive with instant forward or reverse, and many other features. Ask about its 90-day unconditional guarantee!

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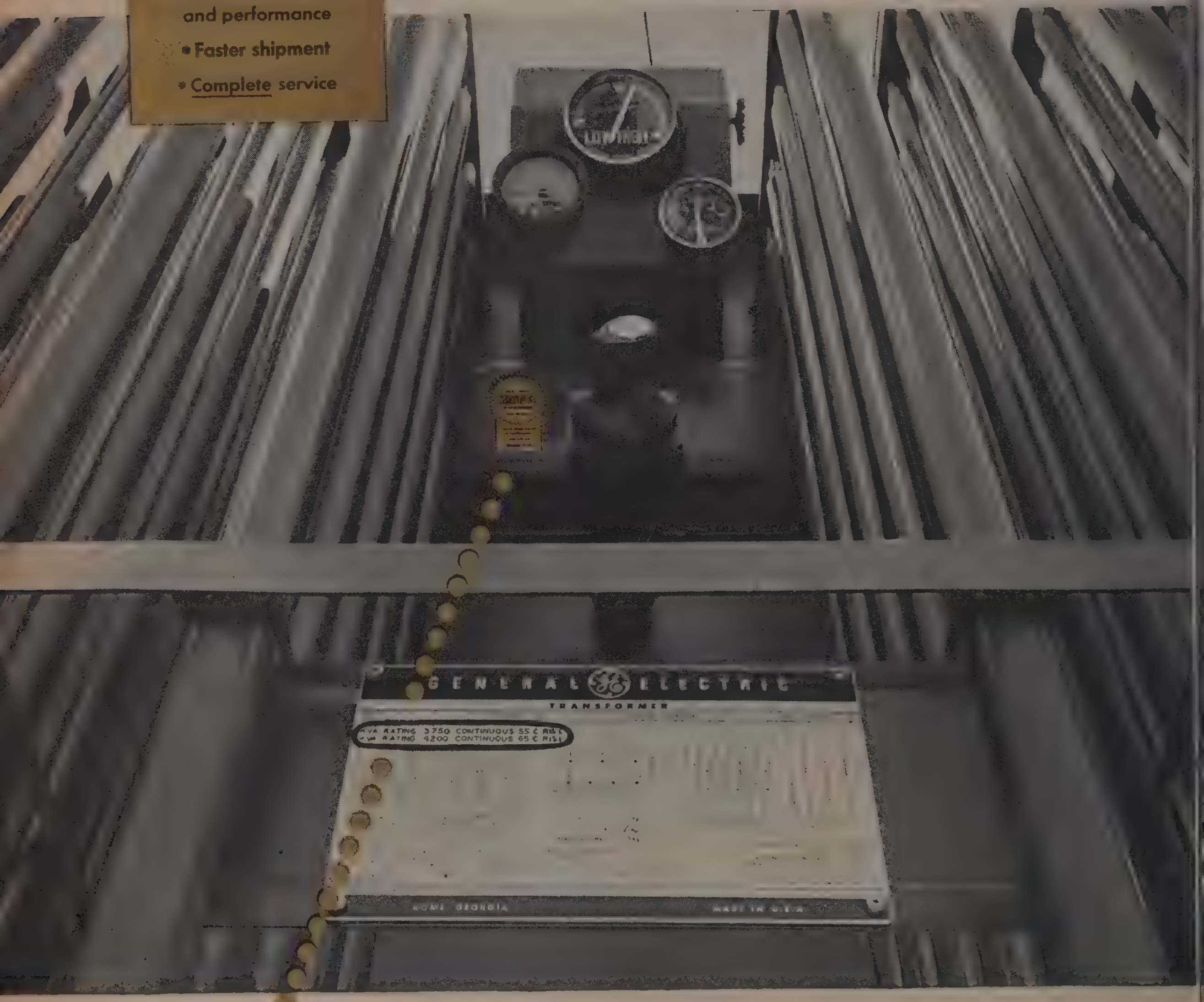

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KVA RATING 3750 CONTINUOUS 55 C RISE
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With this seal, General Electric certifies full value for your transformer dollar; full value in terms of superior basic design, features, and performance . . . plus faster order handling and shipment . . . plus complete service before, during, and after installation. No other transformer manufacturer can match this complete General Electric package.

continuous loadability

General Electric's new Permalex* insulation system increases medium transformer continuous kva capability, or gives five times longer transformer life

Now, as standard on all medium transformers**, and at *no extra price,* General Electric uses Permalex insulation . . . a system permitting transformers designed for 55 C rise to operate at 65 C rise with 12% more continuous capacity!

For example, a 3750-kva, 55 C transformer with Permalex will operate at **4200 kva,** 65 C rise with normal life expectancy. Or, if you prefer to operate the unit at 55 C, you can expect five times the life of present insulating systems! Fan-cooled rating increments remain the same and can be applied at the 65 C operating condition. Also, Permalex is *completely compatible* with everything in the transformer.

The Permalex system used in General Electric medium transformers features Formex† wire and cyanoethylated paper insulation. Formex insulated wire offers exceptional dielectric strength, outstanding thermal stability and high resistance to moisture effects. Cyanoethylation, which replaces many moisture producing molecules with non-moisture producing molecules, raises the thermal endurance of paper and retards the formation of water.

Ask your G-E Apparatus Sales Engineer to point out the many ways you save with Permalex insulated transformers . . . another result of General Electric's *continuing* Certified Full-value Transformer Program. General Electric Company, Schenectady 5, New York. 416-29

OLD-TYPE INSULATION – 55 C

3750 KVA

$5.25/KVA

PERMALEX INSULATION – 65 C

4200 KVA

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PERMALEX INSULATION gives you extra kva at no additional transformer cost. The result is more economically uprated substations because of the lower cost per kva with no increase in transformer size.

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750 kva	840 kva	966 kva
1000	1120	1288
1500	1680	1932
2000	2240	2576
2500	2800	3500
3750	4200	5250
5000	5600	7000
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FORMEX TURN INSULATION with cyanoethylated paper insulation provides high dielectric strength, outstanding resistance to moisture and much longer life for medium transformers.

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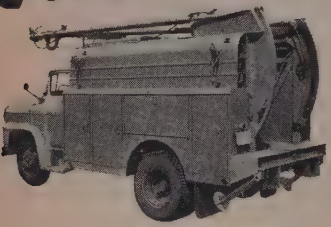

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. . . available in 9′ to 14′6″ lengths with mechanical or hydraulic winch and derrick, or any other special or custom equipment desired. Compartments can be arranged to your specifications.

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. . . for ½-, ¾-, and 1-ton chassis. Electrically welded into one unit with six waterproof compartments, recessed paddle handles keyed alike and fender skirt protected with die-formed rolled edges. Built for safe, dependable service . . . will outlast several chassis.

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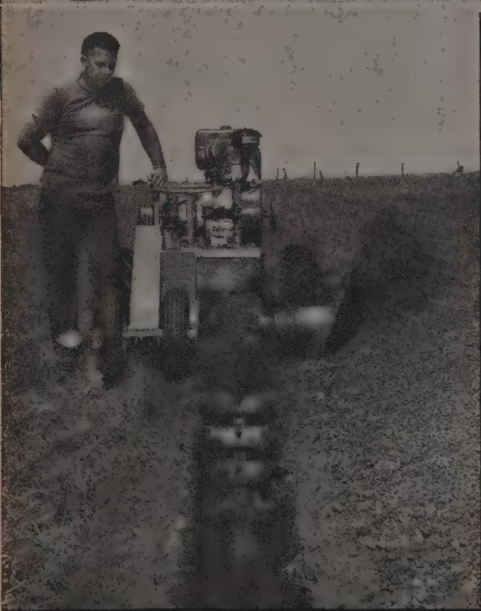

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temperature. Further, moisture, which exists in a combined form with the insulating material, can be released by application of heat. The results of this are much the same as wetting the insulation at room temperature. Since the insulation's absorption is increased by temperature rises, failure often occurs by thermal breakdown under electric stress rather than by flash-over or disruptive failure common at normal temperatures. Test of motor insulation should be done at the motor's full load operating temperature.—F.W.G.

Aluminum Conduit

QUESTION C38—In the use of rigid aluminum conduit outdoors, are there rules for special fittings to prevent galvanic action? Must the conduit have air space for brick walls, concrete and wood walls? Must locknuts be cadmium plated? If used indoors, what fittings are required? Is aluminum conduit permissible in concrete slabs?—V.S.

ANSWER TO C38—Galvanic action between two metals is usually not of serious consequence except in the presence of constant moisture. Galvanized steel fittings may be used except in hazardous locations or corrosive atmospheres, where aluminum fittings should be used. Aluminum may be placed in concrete slabs. However, if calcium chloride or other salts are present, it should first be coated with asphalt or bituminous base paint. The aluminum conduit should always be coated if buried in soil. Joints should be lubricated with one of the commercial preparations or a lubricant made up of half and half zinc dust and petroleum. This will prevent frozen joints which otherwise might occur.—F.W.G.

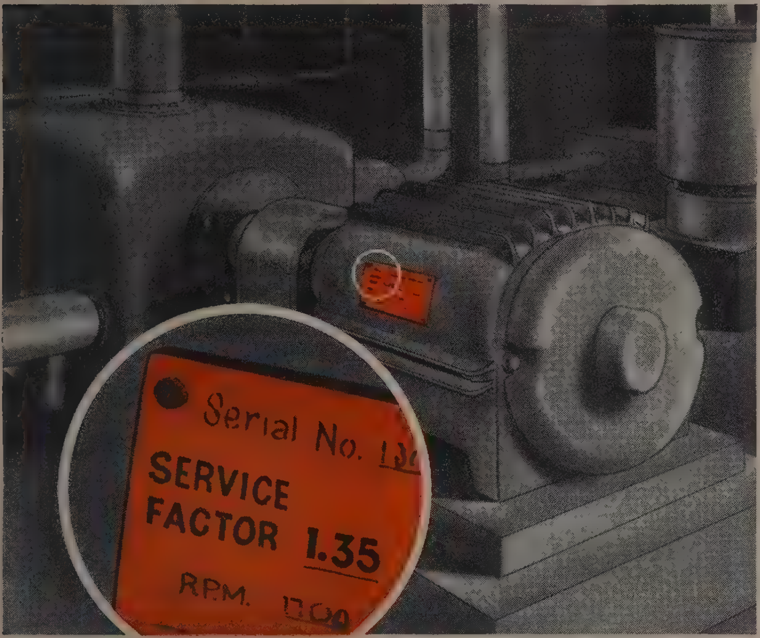
ANSWER TO C38—Much has been written about the advantages and disadvantages of aluminum rigid conduit in the past two years. Time and experience have a way of proving or disproving specific applications of any product. As a result, the NEC may eventually contain rules on what precautions are necessary with aluminum conduit installations. In the interim period, we can follow sound design practices, which will provide a satisfactory installation.

To answer the questions of V.S. more specifically, we can answer them in the order asked.

While there are no "rules" for

SILICONE NEWS from Dow Corning

New Service Factor Motors Cut Costs



Specify High Service Factor Motors for lowest initial cost, lowest operating costs . . . maximum reliability.

Leading manufacturers now offer motors designed to an entirely new concept. These motors are available in standard NEMA frames of the same size used for conventional motors of the same rating, but look alikes don't perform alike.

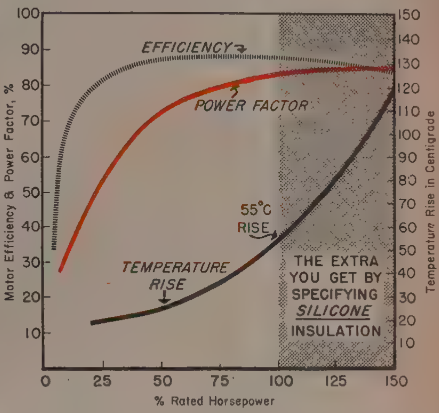
These new motors, insulated with Dow Corning Silicones, have a built-in reserve to carry overloads of twenty-five to fifty percent above nameplate horsepower rating. Here's what this means to you:

Simplified Motor Specifications: Specify motors that are silicone insulated for high service factor. With nameplate horsepower ratings identical to nominal loads, these motors will handle temporary, or even continuous overloading. No need to calculate maximum possible load and add a safety factor. It's already built in.

More Efficient Power Use: Power factor problems are reduced . . . excessive power bills resulting from part-load motor inefficiencies are brought in line. Because motors operate at rated output, the need for capacitors to correct power factor is substantially reduced.

Less Installed Horsepower: With motors rated to match normal loads, total installed plant horsepower will be substantially less. Using conventional methods of determining distribution system needs, transformer and switchgear requirements are lower—less costly units can be safely specified.

Motors insulated with Dow Corning Silicones for high service factors are available now from leading motor builders. For more information on what silicone insulated equipment can mean to you, write Dept. 2808.



How do manufacturers build so much extra into a motor? By substituting an insulation system made from Dow Corning Silicones for the Class A insulation system used in standard lines. Only the insulation changes. Frame, electrical steel and copper remains the same. And there's one change on the nameplate.

Service factor rating goes up. On a TEFC motor, for example, service factor goes up from 1.00 with Class A insulation materials to somewhere between 1.25 and 1.50 when silicones are used, depending on manufacture and horsepower rating.

Handling liquid of varying viscosity, this 5 hp, 1.25 service factor motor withstands overloads, including those created by excessive tightening of pump packing glands.

Motors insulated with Dow Corning Silicones give reliable operation in almost any surroundings—regardless of high ambients, moisture, many corrosive atmospheres. And on the basis of capability, high service factor motors generally cost less than conventional motors.

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5 Sizes for ⅛" to 8" Pipe, Conduit or Rod

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The Ridge Tool Company, Elyria, Ohio, U.S.A.

special fittings for aluminum conduit, cast aluminum conduit fittings, with low copper content, are readily available and widely used with aluminum conduit, particularly in corrosive atmospheres. In general use applications, no difficulty has been reported with the use of steel fittings in connection with aluminum conduits.

Any conduit, steel or aluminum, should have an air space between it and the surface on which it is mounted, where the installation is made in a wet location or where walls are frequently washed. This is a requirement of the NEC, where, in Section 346-4, a ¼-in. air space between the conduit and supporting surface is required in any wet location. This applies to aluminum and steel conduits alike.

Evidence thus far has not indicated the need for special locknuts and bushings for aluminum conduits in general applications. And in corrosive or wet locations, locknuts and bushings should not be used. Instead, threaded watertight boxes and fittings are required.

My comments answer the question about the types of fittings desired for aluminum conduit installed indoors. Here again, unless the conduit is installed in a corrosive or wet location, standard types of fittings have been used without adverse results.

There is no NEC rule prohibiting aluminum conduit in concrete slabs. However, tests and experience indicate that if calcium chloride or similar anti-freeze agents are used in concrete mixtures, aluminum conduits should be coated with any common asphalt paint. The same treatment should be applied to aluminum conduits installed in soil. In fact, to prolong the life of steel conduits, similar coatings should be applied under the same conditions of use as just mentioned for aluminum conduit.—J.W.

Securing Bolts

QUESTION D38—About two years ago we installed a 4160-volt, 500-hp wound-rotor motor. At periodic checks (every two months), we found the bolts on the resistor bank in the rotor circuit loose. We have been told that there is no solution to our problem, except that we should continue to check and then tighten as necessary.

Has any reader had similar experiences, and is there any way we can overcome the above condition? —J.M.

ANSWER TO D38—I had very much the same trouble as J.M., and by putting several lock washers spaced by flat washers the tension can be maintained constant so that periodic tightening can be eliminated.—E.S.H.

ANSWER TO D38—There is a relatively new product on the market that should solve your problem with loose bolts. This is a liquid sealant called Loctite, manufactured by American Sealants Company, 395 Woodbine St., Hartford, Conn. It is available in ten grades of varying viscosity, strength and torque ratings. The threads of the bolts are simply coated with the liquid and then tightened into place. The liquid is rather unique since it will not harden while exposed to air, but only after the bolt is tightened. Complete information on grade selection for various size bolts is available from the manufacturer. The bolts may be removed when desired.—F.W.G.

Can You Answer These QUESTIONS?

QUESTION L38—Recently we had a failure on a 1000-hp 6000-volt motor that prior to start-up had a Megger reading of 320 megohms. This resulted in a costly rewinding job that we would like to avoid in the future.

Is there an insulation tester on the market that can predict the exact condition of the insulation under all circumstances?—J.A.M.

QUESTION M38—We are designing a counter-balanced hoist on the escarpment of the Cumberland Plateau to lower quarried quartzite stone to valley level where it will be machine cut into building shapes and sizes.

Since the loaded car will require considerable braking to maintain safe speeds on the 55% grade, we are exploring the possibilities of electric braking on the 300 hp, 2300-volt, 3-phase, ac motor by either one of the conventional methods; such as, dc dynamic braking, capacitor braking, regenerative braking, or by the not too successful plugging method.

We are informed on the handicaps of the latter with the serious overheating of the resistor banks and the subsequent early deterioration thereof. Then too, if you will observe the diagram, it is obvious

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RIDGID
No. C-14 for up to 2" Pipe and Fittings
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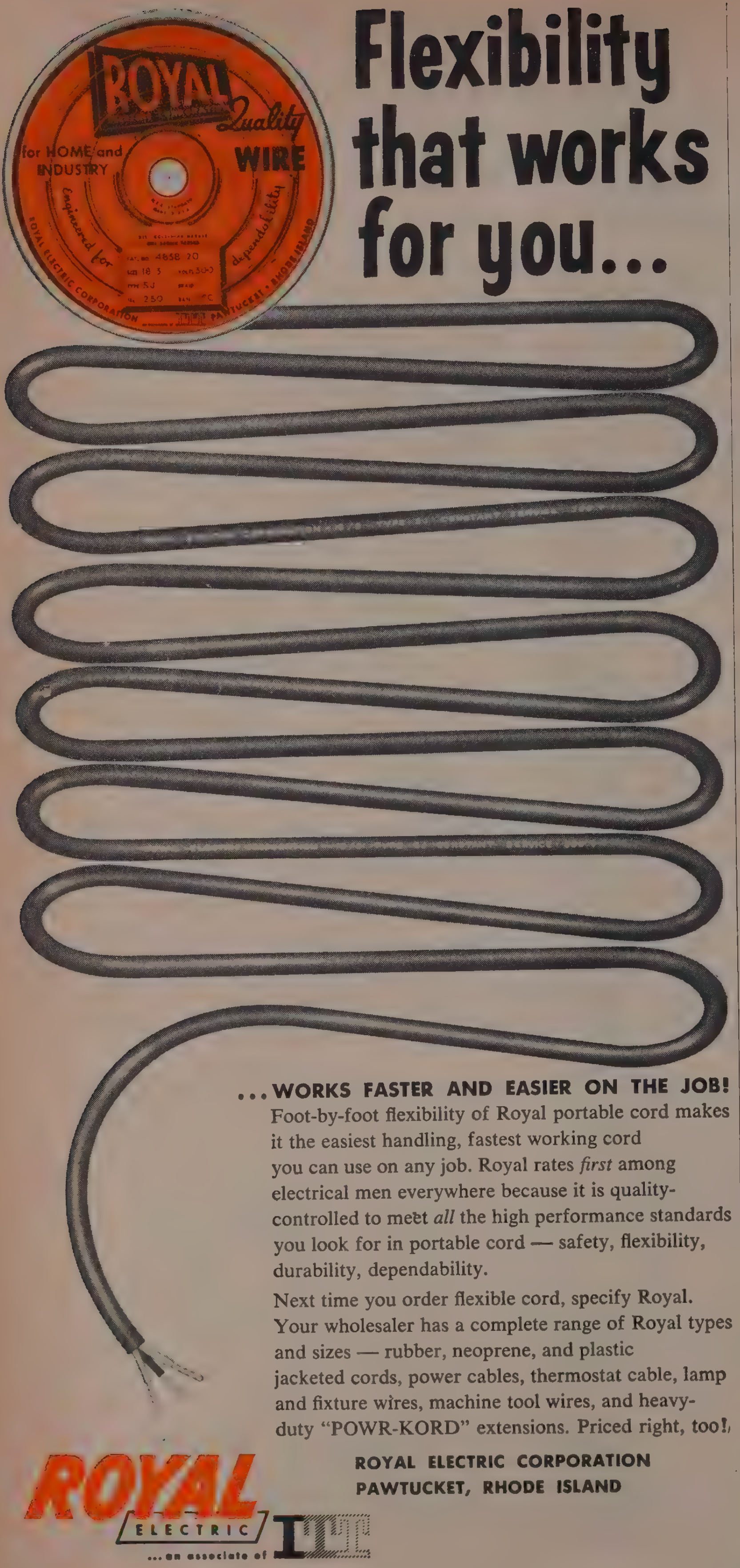

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Foot-by-foot flexibility of Royal portable cord makes it the easiest handling, fastest working cord you can use on any job. Royal rates *first* among electrical men everywhere because it is quality-controlled to meet *all* the high performance standards you look for in portable cord — safety, flexibility, durability, dependability.

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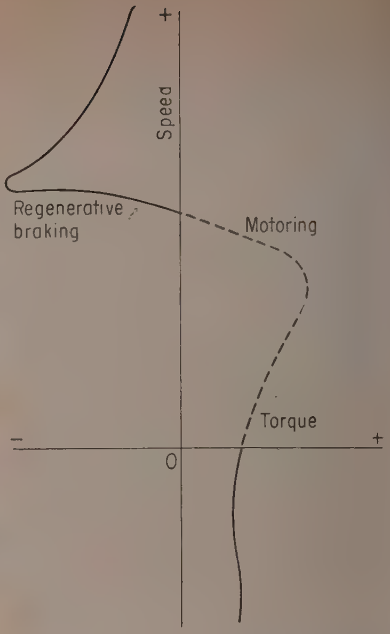


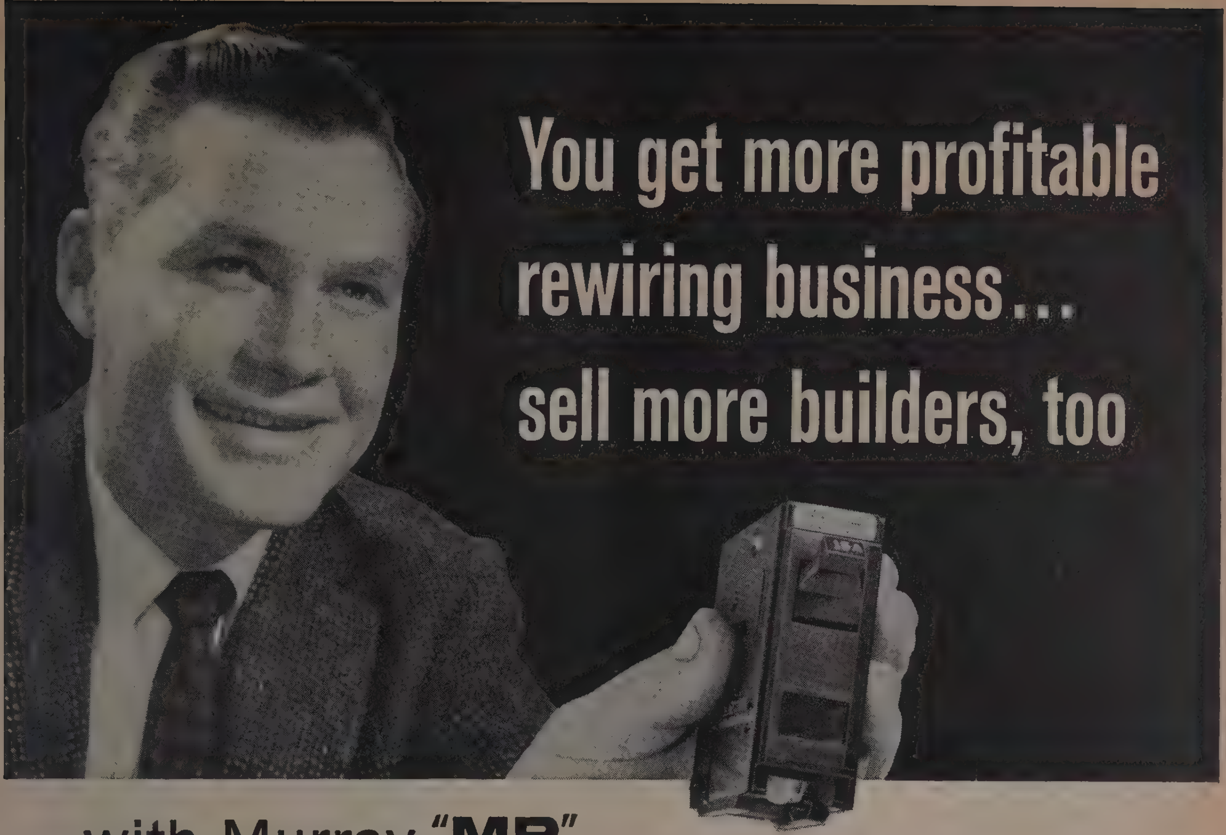
that if power is not disconnected from the motor as it reaches zero speed, the motor will accelerate up to the synchronous speed in the reverse direction. This means the hoist engineer is relied on to cut off power at the critical moment, unless some automatic means can be provided such as a zero speed switch.

It is suspected too, that the motor has high losses when operating in the plugged position of the controller. It is estimated that such losses may total up to thrice normal values as plugging to a stop is achieved in comparison to those of accelerating from zero to synchronous speed.

It will be appreciated if experienced mine power men will elaborate for us on the advisability of using regenerative braking with the thought of reducing our monthly billing to some small degree without risking early replacement of the resistor banks through overheating, plus the hazard of flashovers across the slip rings in the inadvertent instances of overspeeding.—W.W.

QUESTION N38—What percent voltage unbalance can be tolerated on a 3-phase, 240-volt or 480-volt delta system for 3-phase motor operation? What effect does the voltage unbalance have on the motor winding?—H.H.L.

PLEASE SEND IN YOUR ANSWERS BY SEPTEMBER 15



You get more profitable rewiring business... sell more builders, too

with Murray "MP" GUARANTEED FOR LIFE Breakers

WHY SQUEEZE profits on rewiring jobs, when you can more easily sell quality jobs at profitable prices. By offering customers a breaker that's *guaranteed for life*, you win confidence, make your sales job easier.

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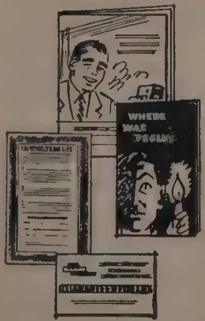

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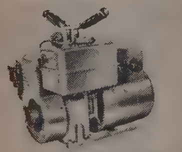

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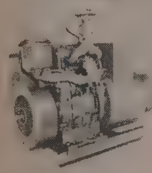
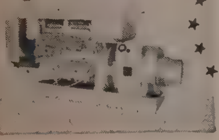




Here's rare news for these days: prices cut on every single model in this great all-purpose Universal line of electric light and power plants. They were reasonable before. They're even greater bargains now — starting as low as $195. And look at the choice in this newly-expanded line! It gives you power for every purpose big or small, for emergency, intermittent, or constant use. Get complete facts on this fast-moving economy line, famous for rugged reliability and trouble-free operation.

Universal of Oshkosh

Write to:

UNIVERSAL MOTOR COMPANY
438 Universal Drive
Oshkosh, Wisconsin

ESTIMATING FORUM—III

[FROM PAGE 87]

rather large monetary investment for James.

Fig. 1 shows an estimate for the industrial project under normal conditions based on the contractor having adequate tools and the organizational manpower to do the job.

Excess Costs

Fig. 2 lists the estimated excess costs residential contractor James would encounter if he were to do an industrial project of this size. To anyone familiar with the hazards a contractor faces when taking work outside an established regular line of activity, this estimate will seem modest. Excess labor, alone, could well be 10% above normal (or $6,400).

Moral Obligation

James would also be under a strong moral obligation. His builder friend would expect him to install the electrical work with the same dispatch as contractors regularly doing such work. Chances are that this would not be possible. Among other things that must be taken into account are the following:

The low bid might be faulty and the $5,000 would be needed to cover shortages.

The architect might not be in accord with the arrangements.

Possibility of procurement failures.

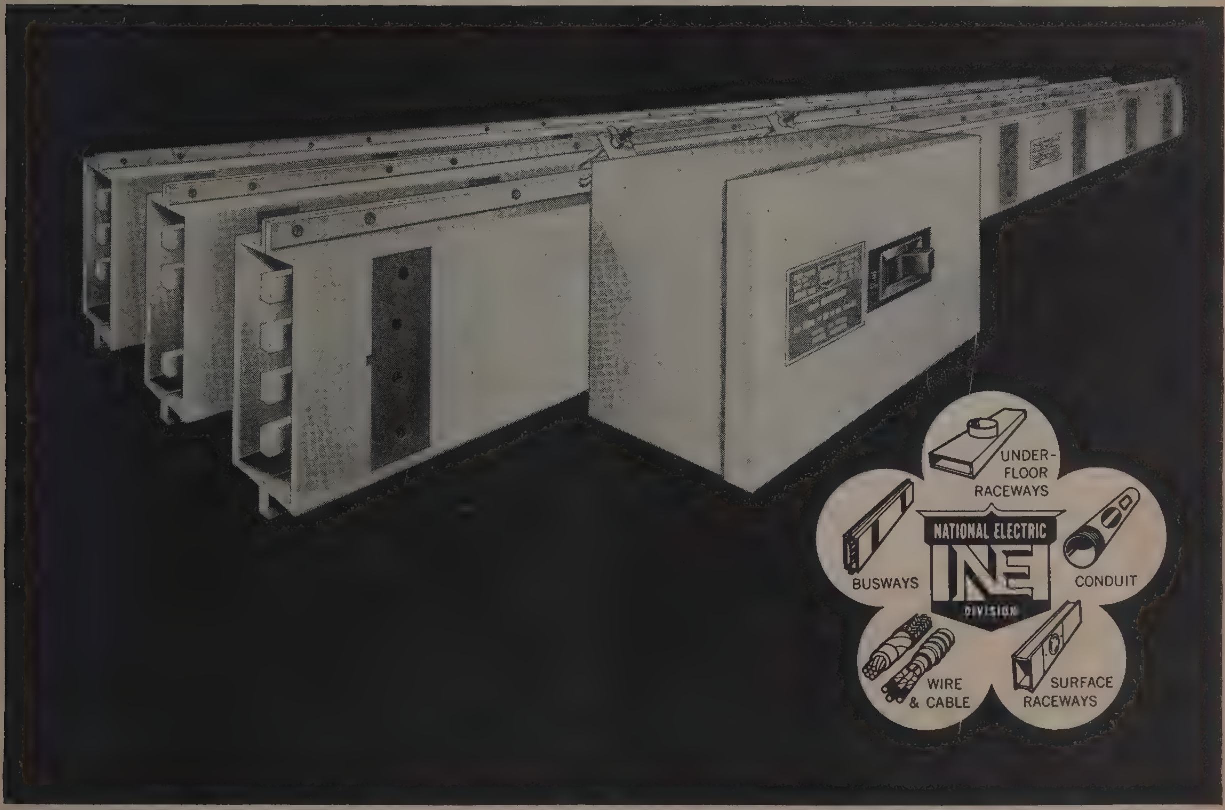
Effects on the regular work.

Special Cases—We have assumed that contractor James was not considering addition of industrial work to his activities. Had he wanted to enter the industrial field, conditions might warrant this venture. Normally, it would be far better for him to start on a smaller scale which would involve much less "excess" expense.

According to the "one-third volume rule" (see page 156, *Electrical Estimating*, McGraw-Hill Book Co.), the maximum size project James should undertake would be one-third of his annual $500,000 volume—or about $167,000. And, such a project would have to be in his "regular" line of work. Any exceptions to this would invite out-of-pocket expenditures.

HERE'S A NEW, BETTER METHOD OF ELECTRICAL DISTRIBUTION

N-E 100 AMP SPEEDBUS



"Speedbus," National Electric's new 100 amp busway, goes in so fast, and is priced so low that in most installations it actually is more economical to use than conduit or cable!

Never before has as compact and convenient a distribution system been made available. Never before has such wide application of busway been possible. In almost any commercial or industrial location where both power and lighting are required, this new, completely flexible, factory-assembled busway will serve best.

"Speedbus" can be plugged in from either side, back-to-back—16 usable outlets in every ten foot length. Bolted connections on case and conductor assure positive grounding continuity and electrical contact. Erection of "Speedbus" is simple—using only hand tools. Lightweight sections incorporating aluminum bus bars are easy to lift, and require fewer hangers.

For complete information on how to improve your electrical lighting or power distribution while saving money, call N-E Man, or write for literature. *National Electric Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

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PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

Sports lighting requires a combination of short-range and long-range floodlights to provide good visibility for participants and spectators, and to add dramatic effect. Economical Revere Eliptor floodlights on Revere hinged poles illuminate this race track. Revere "2000" Series long-range, rear-serviced floodlights are mounted on the grandstand roof to increase intensity of illumination at the finish line.

Solve any outdoor lighting problem with Revere's complete, matched line

Peak lighting efficiency for any outdoor lighting application calls for a number of components, each designed to do a specific part of the job. Solving outdoor lighting problems is much easier when you install Revere equipment because—

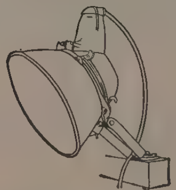
1. Revere offers the widest line, making it easy for you to select the exact combination of components to solve *any* outdoor lighting problem. Everything you need from one reliable source simplifies ordering, assures on-schedule delivery of all components.

2. Revere offers matched components . . : *structurally* matched for strength, balance, and perfect fit; *design* matched for peak lighting efficiency and best appearance.

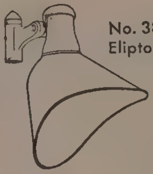
3. Revere offers easier installation—lights, poles and accessories are made for each other. Installation is fast, easy, trouble-free.

Write for Revere's catalog of outdoor lighting equipment. You can solve any outdoor lighting problem with this complete, matched line.

Revere components used to light race track



No. 2000 Series
Rear-Service
Floodlight



No. 3803
Eliptor Floodlight

No. 199-D-30
Hinged Pole

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Questions on the Code

Answered by:

B. A. McDONALD, *New York Board of Fire Underwriters, Rochester, N. Y.*
B. Z. SEGALL, *Consulting Electrical Engineer, New Orleans, La.*
R. E. WARD, *Chief Electrical Inspector, Insurance Department, State of Tennessee, Nashville, Tenn.*

Ten-Foot Taps

Q. *There is a question about Section 240-15, Exception 5 concerning the overcurrent protection in the drawing below. It is my contention that the No. 1 conductor, where tapped to the 250 MCM conductor as shown, should be protected by a 100-amp fuse or breaker.*

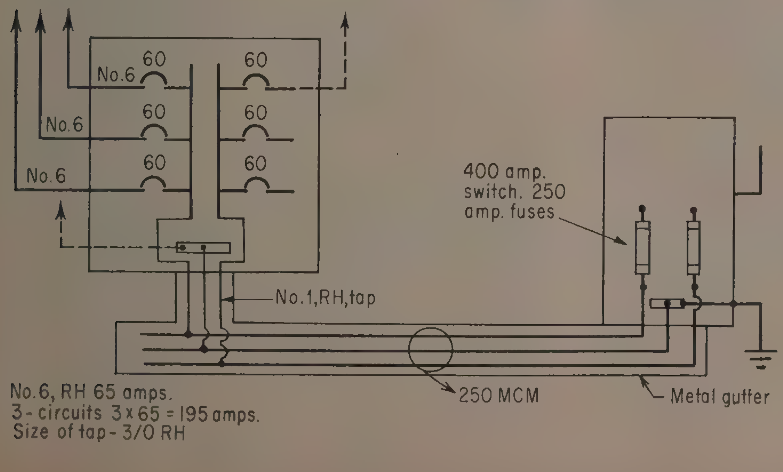
The No. 6 conductors, feeding panels on the first and second floor, are protected by the 60-amp breaker. As I see it, the No. 1 conductor is protected only by the 250-amp main fuse.—E.C.H.

A. The provisions of Section 240-15, Exception No. 5, are quoted as follows:

"Taps Not Over 10-Ft Long. Where (1) the smaller conductor has a current-carrying capacity of not less than the sum of the allowable current-carrying capacities for the conductors of the one or more circuits or loads supplied, and (2) the tap is not over 10 ft long and does not extend beyond the switchboard, panelboard, or control devices which it supplies, and (3) except at the point of connection to the feeder, the tap is enclosed in conduit, electrical metallic tubing, or in metal gutters when not a part of the switchboard or panelboard."

According to your diagram, the No. 1 tap is not over 10 ft long, and does not extend beyond the panelboard. The tap conductor is protected by a gutter. These are assumptions which appear to be correct. The size of the tap, however, does not satisfy the first condition which requires it to have a current-carrying capacity "of not less than the sum of the allowable current-carrying capacities of the conductors of the one or more circuits or loads supplied."

The panelboard under discussion contains six 60-amp circuit-breakers. I assume that they are used to protect the three, 3-wire No. 6 feeders running to panelboards on the first and second floor. This point is vague since the drawing does not clearly indicate if they are 1 or 2-pole breakers. On the basis of single-pole breakers, and Type RH insulation, we have three 3-wire No. 6 feeders served through the panelboard. The current-carrying capacity of each feeder is 65 amps. The total current capacity of all conductors is 195 amps. As a result, the smallest tap recognized would be 3/0 RH, and such a tap would be considered as properly protected by the 250-amp fuse protecting the 250 MCM feeder. It is significant to note that the total current flowing through the tap is limited by the 60-amp circuit breakers which prevents overloading, and short-circuit protection is covered by the 250-amp fuse in the main feeder. The principle of protection is somewhat similar to that recognized for the protection of motor branch-circuit conductors. Under such conditions it is not necessary to protect the tap with a 100-amp fuse or circuit-breaker, and since the panelboard is not an appliance branch-circuit panelboard, the provisions of Section 384-16 do not apply.—B.A.McD.—8/1/60



Heating Cable

Q. *I recently purchased a unit of heating cable to install in a concrete floor. This cable is listed by Underwriters' Laboratories and manufactured by a reputable, recognized manufacturer. The non-heating leads are single conductor U.F. cable. Section 339-3(d) states:*

"Type UF cable may be used for interior wiring in wet, dry, or corrosive locations under the recognized wiring methods of this code, and when installed as non-metallic sheathed cable it shall conform with the provisions of Article 336 and shall be of the multiple conductor type."

From the above my interpretation is that the UF cable should be multiple conductor type. Section 339-3 (e) (8) prohibits the use of underground feeder when imbedded in poured cement, concrete or aggregate.

Am I in violation of the NEC when I install this single conductor UF cable with a few inches of such cable imbedded in concrete?—B.R.

A. In my opinion, no, as the intent of the code will be met in a proper installation. Section 422-23(d) states:

"Electrical space heating systems employing methods of installation other than covered by Part E of this Article may be used only by special permission."

From the above the inspector has the right to accept such an installation as I do know that UL has approved and listed cable with non-heating leads using underground feeder, single conductor cable. I do not consider the use of underground cable for this purpose as being the same as non-metallic sheathed cable. This application is the same as its use when emerging from the earth to a junction box located above the earth. In this case protection is required where the cable is exposed as is recorded in 422-37(d) which reads:

Clarence Darrow Homes, Chicago Housing Authority, Chicago, Illinois
Architect: L. R. Solomon & Associates, Chicago, Ill.
General Contractor: Sumner-Sollitt Company, Chicago, Ill.
Electrical Contractor: Carson Electrical Construction Co., Chicago, Ill.

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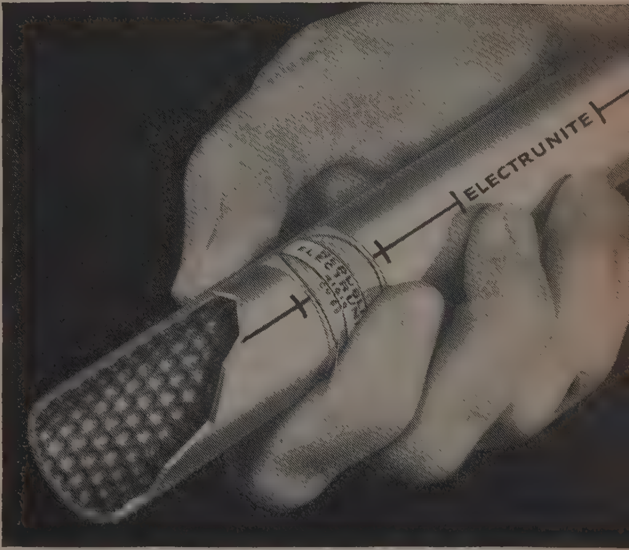

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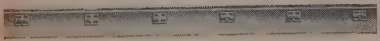
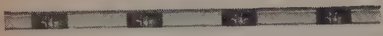


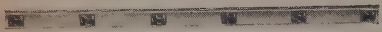
PLUGMOLD 2200 serves as baseboard, multi-outlet system, perimeter raceway. Holds up to 10 No. 10.

MORE



PLUGMOLD 2100, for Wiremold devices rated at 15A, 125V; 10A, 250V. Without devices, holds up to 5 No. 6 conductors.

OUTLETS



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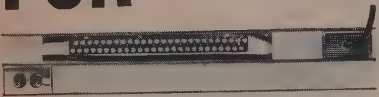

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"Leads shall be protected where they leave the floor by rigid metal conduit, electrical metallic tubing, or by other approved raceways extending to the junction box."

Certainly no hazard is involved as tests will show the insulation of the non-heating leads without heat applied to be better than the insulation on the heating cable itself. Therefore, the non-heating leads should outlast the heating cable.

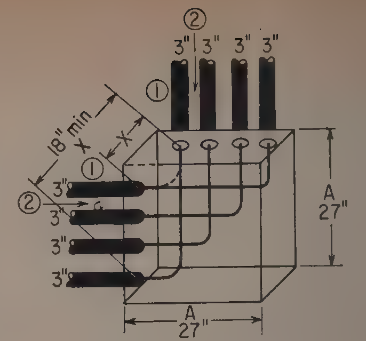
With reference to Section 339-3(e)(8), I am informed by James E. Goff, vice president in charge of engineering, Ceilheat, Inc., manufacturers of electric heating equipment, 5212 Homberg Drive, Knoxville, Tenn., whose floor cable is listed by UL, such cable having underground feeder leads, that it is far more dangerous to pull the heating cable up to the conduit that leaves the floor going to the thermostat box in a floor installation that it is to have the UF cable imbedded in the concrete such as you describe.

Along this same subject, I have examined one other report where UL has given approval in a listing by report where thermoplastic wire is used as the non-heating leads, such leads having been imbedded in concrete with rather severe tests conducted. The report shows that after tests the percentage of average tensile strength per square inch, and the average elongation is the same as before the tests were made, while the tests show that the resistance wire was lower in both instances. Therefore, the non-heating leads should outlast the heating part of the cable.—R.E.W.—8/60/2

Pull-Box Computations

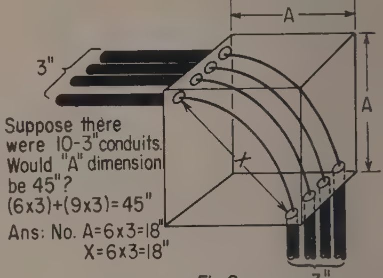
Q. *In your March* 1960 *issue there is an answer to a question on the code (page* 197*) which is questionable. There is nothing wrong with your literal translation of the code article in question, but I can't believe that the interpretation follows the original intent. I find it hard to believe that the diameters of additional conduit must be added to the "6 x diameters" dimension, unless these additional conduits lie in the plane of the path of the cable. What would be the advantage of increasing the box dimensions in this direction if the cable radii are not increased?*

I might add that the construction standards of at least two large outstanding companies in the East do not agree with your interpretation.



A=(6x3)+(3x3)=27 in.
X=(6x3)=18" min.

Fig. 1



Suppose there were 10-3" conduits. Would "A" dimension be 45"?
(6x3)+(9x3)=45"
Ans: No. A=6x3=18"
X=6x3=18"

Fig. 2

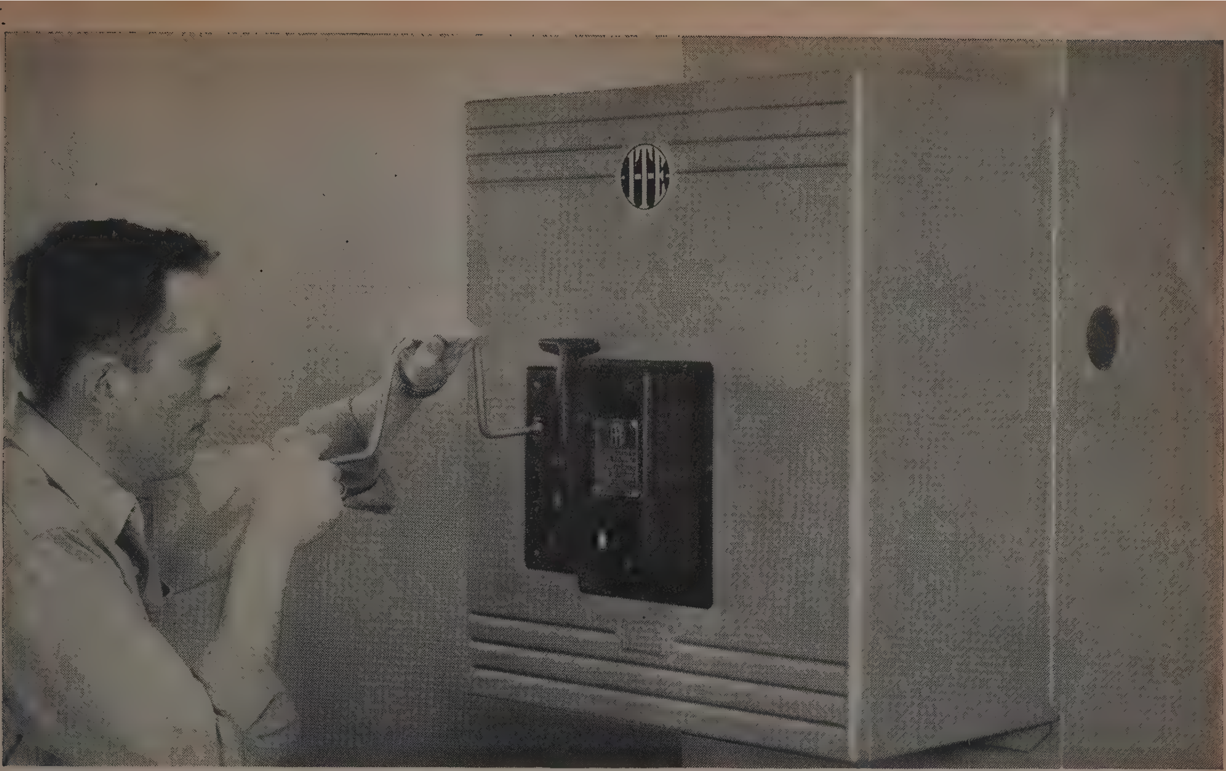
Above are sketches showing my interpretation of this code article.
—J.J.F.

A. The above observation is an excellent example of how a literal interpretation of a code rule may not convey the intent when the rule was formulated. For the convenience of our readers, the rule involved is quoted as follows:

"Section 370-18(a-2). Pull and Junction Boxes.

"Angle or U Pulls. Where angle or U pulls are made the distance between each raceway entry inside the box and the opposite side of the box shall not be less than six times the trade diameter of the raceway. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries on the same wall of the box. The distance between raceway entries enclosing the same conductor shall not be less than six times the trade diameter of the larger raceway."

Fig. 1 shows an application where the intent of the rule coincides with a literal wording of the code. On such an application, dimension "A" must be increased in proportion to the number of conduits entering the box. The wire arrangement emphasizes the code provision which requires the distance between raceway entries enclosing the same conductors to be not less than six times the trade diameter of the larger raceway. The conductor arrangement shown



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would satisfy this requirement. As shown by the dotted line, the conductors in conduit No. 1 vertical could not enter conduit No. 1 horizontal and satisfy this rule even on the basis of a $\frac{1}{8}$-in. locknut clearance. It appears, however, on the basis of a $\frac{1}{8}$-in. clearance, that the conductors in conduit No. 2 vertical could sweep directly into conduit No. 2 horizontal. This important factor must be considered when designing a pull or junction box.

Fig. 2 shows an application where a literal reading of the rule appears to be in conflict with the intent. According to the code, the "A" dimension of this box would be (6 times 3) plus (3 times 3), or 27 in., and this dimension would increase in proportion to the number and size of additional conduits entering the box. It appears self-evident from the diagram that a box with an "A" dimension of 18 in. would fully satisfy the intent of the code. If there are no joints involved, one is inclined to speculate that a box in the form of an angle would adequately cover the situation.

Our thanks to J.J.F. for directing our attention to an apparent code fallacy which deserves the serious consideration of Panel No. 9 of the NE Code Committee. —B.A.McD.—8/60/3

Grounding Conductor

Q. *How do you arrive at the correct size of system grounding conductor when wires are run in multiple?—W.H.G.*

A. This is covered in Tables 250-94-a, 250-94b and 250-95.

Where a grounding conductor is used to ground

1. an alternating current system, or

2. both this system and its associated service equipment (i.e., a common grounding conductor) Table 250-94a applies.

Where the system is not required to be grounded; e.g., many "delta" secondary systems are not grounded, but the service equipment, i.e., service cable, service armor, service disconnect, etc., is required to be grounded; then Table 250-94b is to be used. Basically, it is the same as Table 250-94a with the addition of the permissible use of conduit, pipe or EMT for the grounding conductor.

When only interior raceways, e.g., conduit, armor, EMT, etc., and equipment, i.e., panelboards, switchboards, switches, controllers, etc., beyond the service equipment are to to grounded, Table 250-95 is to be used for the minimum size of grounding conductor.

Suppose we have a service consisting of a 1200-amp main circuit breaker and three $3\frac{1}{2}$-in. conduits, each containing three 600 MCM RHW conductors and one 4/0 RHW neutral. The total circular mil capacity of this service is

3 x 600 or 1,800 MCM.

Table 250-94a shows the minimum size of copper grounding conductor to be 3/0.

When aluminum wire is being installed, the total capacity would be three 900 MCM cables and one 300 MCM neutral. The total circular mil capacity would be

3 x 900 or 2,700 MCM.

The 3/0 copper conductor would have to be converted to an equivalent current-carrying capacity aluminum conductor. A 3/0 RHW copper conductor has a current-carrying capacity of 200 amps. The comparable aluminum grounding conductor would be 250 MCM.

The same size service for say a delta ungrounded system, e.g., 3/600 MCM RHW conductors, only, could utilize a 3/0 copper conductor, 1-in. conduit or pipe, or a 2-in. EMT for grounding the service raceway, equipment, etc., as shown by Table 250-94b.

Suppose this 1200-amp circuit breaker were just a part of a larger overall system and it was protecting just one feeder of this system. When it becomes necessary to ground this system, Table 250-95 would be applied, and it should be noted that the rating or setting of the overcurrent device, and not the circular mil capacity of the feeders themselves, govern the size of the grounding conductor. In this case the final result would be the same since a 1200-amp circuit breaker requires a minimum of 3/0 copper conductor, or a 1-in. conduit or pipe, or a 2-in. EMT.—B.Z.S.—8/60/4

Parallel Services and Conductors

Q. *Shown (on page 172) are three sketches; and I would like to know if, in your opinion, these are in violation of any NEC regulations. For simplification I am not showing switches, which are not in question, but only the methods of paralleling.*

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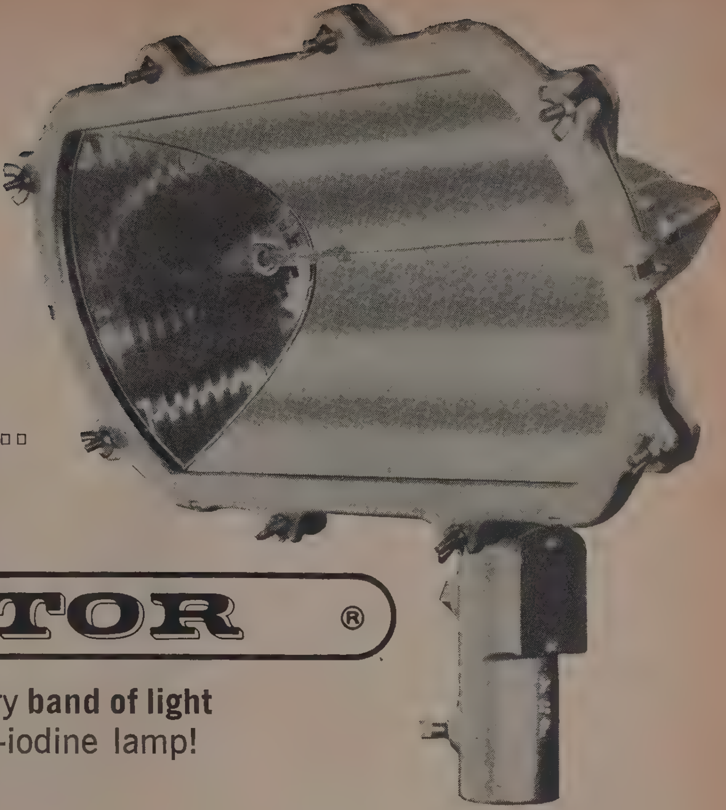

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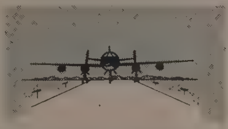

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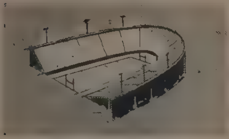

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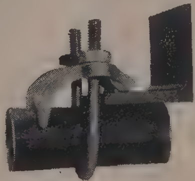

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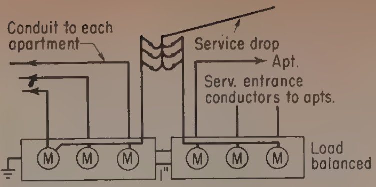

Fig I

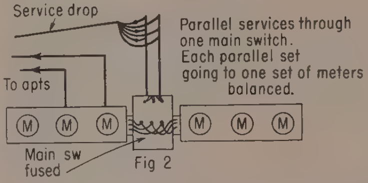
Service drop
Parallel services through one main switch. Each parallel set going to one set of meters balanced.
To apts
M
Main sw fused

Fig 2

Our local utility company issues meter sockets of the trough type, three or four gang. Although the meter sockets are not a point in question here, they do have a bearing on why this service-wiring is done this way.

Wires are parallel into gutter and tapping off these wires to feed cabinet as shown. Should taps be made to both parallel wires or would it be permissible to tap only one of them?

A. I am assuming that the installation shown by Fig. 1 concerns a multiple occupancy building with the meters installed in raintight enclosures on the outside building wall. In this case, we have two sets of service-entrance conductors tapped to one service drop, as recognized by Section 230-2(b) for buildings of multiple occupancy. In this case the conductors are not in multiple (parallel) since each set serves three separate apartments. They do not terminate at a common point at both ends. From the meter enclosure the unprotected service-entrance conductors, enclosed in conduit, run on the exterior face of the wall to service equipment located in each apartment. There appears to be no code violation.

In the case of Fig. 2, the service-entrance conductors are run in multiple from the service drop to the terminals of a main service switch and fuse. From the load side of this switch, taps are taken to serve each set of meters, and these

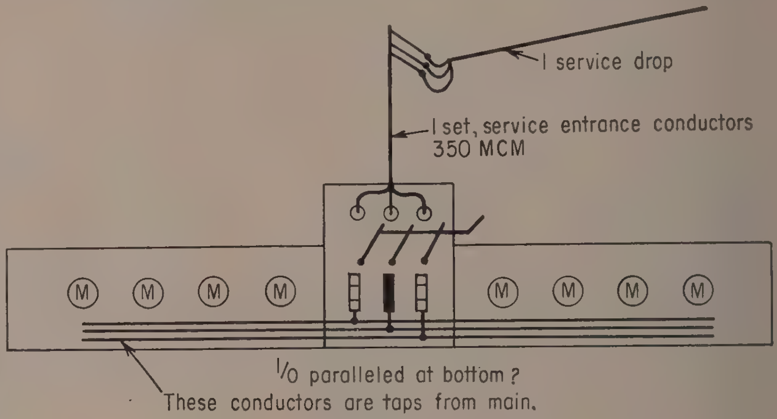
1 service drop
1 set, service entrance conductors 350 MCM
M
1/0 paralleled at bottom?
These conductors are taps from main.

Fig.3

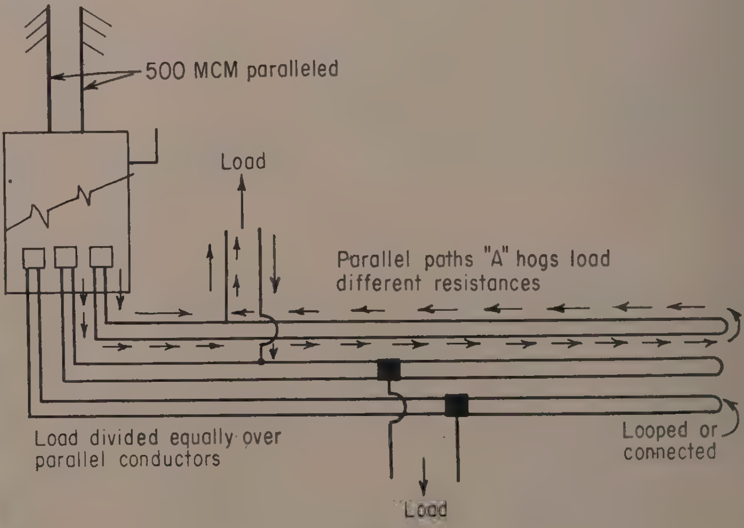
500 MCM paralleled
Load
Parallel paths "A" hogs load different resistances
Load divided equally over parallel conductors
Looped or connected
Load

Fig.4

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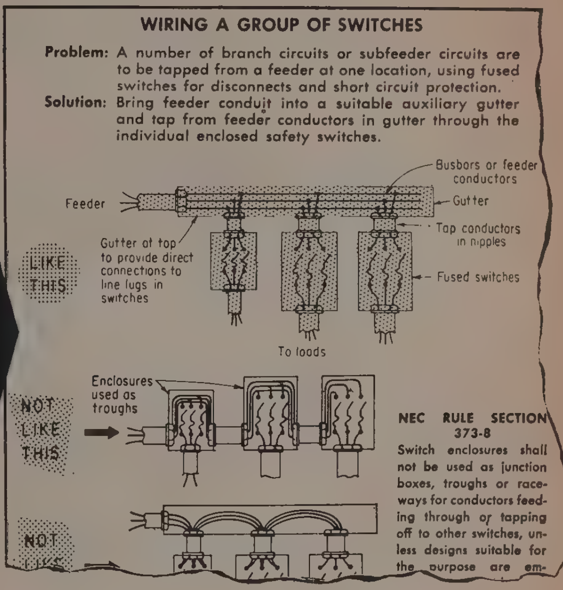

WIRING A GROUP OF SWITCHES

Problem: A number of branch circuits or subfeeder circuits are to be tapped from a feeder at one location, using fused switches for disconnects and short circuit protection.

Solution: Bring feeder conduit into a suitable auxiliary gutter and tap from feeder conductors in gutter through the individual enclosed safety switches.

NEC RULE SECTION 373-8

Switch enclosures shall not be used as junction boxes, troughs or raceways for conductors feeding through or tapping off to other switches, unless designs suitable for the purpose are em-

LIKE THIS
Feeder
Busbars or feeder conductors
Gutter
Tap conductors in nipples
Gutter at top to provide direct connections to line lugs in switches
Fused switches
To loads
NOT LIKE THIS
Enclosures used as troughs
NOT

PLANT ELECTRICAL PEOPLE — This book should be in the reference library of plant electrical engineers, electrical supervisors and electricians.

ELECTRICAL INSPECTORS — Here's a unique presentation of code rules in combination with specific installation details taken from modern practice. The correlation between code generalities and actual job specifics will assist inspectors in many difficult rulings.

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(273-076)

taps continue along the exterior wall of the building to each apartment. If we consider the main switch and fuse as service equipment, the so-called taps become feeders, and they should have overcurrent protection as required by Article 240. If the conductors running through the meters to each apartment are protected by the service overcurrent device, there appears to be no code violation. Such procedure, however, is questionable on the basis of practicability. If each apartment had its own service equipment, as in Fig. 1, I would hesitate to criticize the installation shown by Fig. 2 on the basis of feeder overcurrent protection. The code specifically recognizes the unprotected service conductors shown by Fig. 1, and when one endeavors to increase the degree of safety afforded by the main switch and fuse, I do not believe that a technicality should be used to penalize such an installation. To do so would provoke an argument both inconsistent and illogical. Under such circumstances, I would be inclined to rule that the service equipment installed in each apartment of a multiple occupancy building satisfies the code, and the main switch is supplementary protection, not required but desired.

In the case of Fig. 3, there are no conductors arranged in multiple. Here again we merely take taps from the load side of the switch to each set of four meters.

When taps are made to conductors in multiple, as shown by Fig. 4, both conductors should be tapped. The 1933 edition of Abbotts NEC Handbook covers this question as follows:

> "A group of cables in multiple should be connected together at each end of the run and at any intermediate point where a tap is taken off."

When a tap is only connected to one conductor there are two parallel circuits of unequal resistance feeding the taps as shown on the wiring diagram. This will result in unequal currents flowing over the multiple assembly and one of the conductors will "hog the load" and become overloaded. As a result, the phrase "to insure equal division of the total current between all conductors" under Section 310-10 would not be satisfied. When the tap is made to both of the multiple conductors as shown, the load will be equally divided over both parallel conductors. This question, in view of inquiries received, should be more clearly covered by the code.—B.A.McD.—8/60/5

Service Conductors Inside Buildings

Q. *Please advise me on the following item:*

Several years ago there was a clause in the electrical code that said a service-entrance cable could not be run more than 5 ft after it entered a building. If it had to be run more than the 5 ft, it was necessary to install a disconnect switch and then continue the run to the service circuit box.

I have read article 230 which covers services of the 1951, 1956, and 1959 code books, but have been unable to find this clause.

Please advise me about this clause, whether it is in some other section, or if it has been changed or discontinued.

I have a job in progress where I find it necessary to run the service cable about 7 ft after it enters the cellar before I can mount the service circuit-breaker panel.—A.C.S.

A. In so far as the NEC is concerned, I know of no rule at the present time, or in the past which limited the distance service entrance cable could enter a building before termination at the service equipment.

Section 230-70(b) covers the question as follows:

> "The disconnecting means shall be located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall. See Section 230-45."

Section 230-91 requires the service overcurrent device to be an integral part of the service disconnecting means or shall be located immediately adjacent thereto, unless located at the outer end of the entrance.

The provisions of Section 230-70(b) are general in nature. As a result, the authority enforcing the code has the responsibility for interpreting the rule, delegated to him by Section 90-7. The 5-ft maximum rule is an interpretation established by some inspection authorities more than 30 years ago. In most cases it may be readily satisfied when the service-entrance conductors are run on the outside wall of the building to a point where the service equipment is located on the inside of the wall. Unusual circumstances may warrant special consideration, and the authority enforcing the code should be consulted when an exception appears to be necessary.—B.A.McD.—8/60/6

CO-CHAIRMAN OF EMEA's biennial electrical show, Bob Marcum of Hughes Aircraft, chatted between parallel lighting-conference sessions with Bob Clubley, General Electric Lighting Consultant, who appeared on the program as Chairman and speaker for two industrial sessions.

NEC Official Interpretation No. 461

NFPA's Electrical Correlating Committee has reviewed and released Official Interpretation No. 461 (effective May 23, 1960) of the current National Electrical Code.

The interpretation, developed through standard committee procedure, covers (1) the use of service entrance cable without individual insulation on the grounded conductor; and (2) location of a 3-wire service entrance cable.

Official text of the interpretation follows:

INTERPRETATION NO. 461

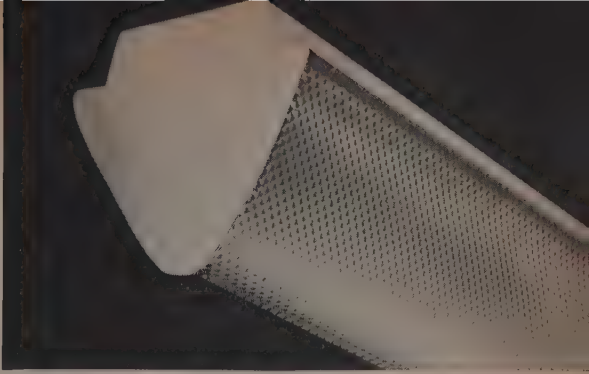
Question No. 1—Would the use of service entrance cable without individual insulation on the grounded conductor installed from main disconnect and overcurrent units (outside of building) to feed a 3-wire 120/240-volt lighting and appliance branch circuit panel located 40 ft. inside of building be in compliance with Section 338-3?

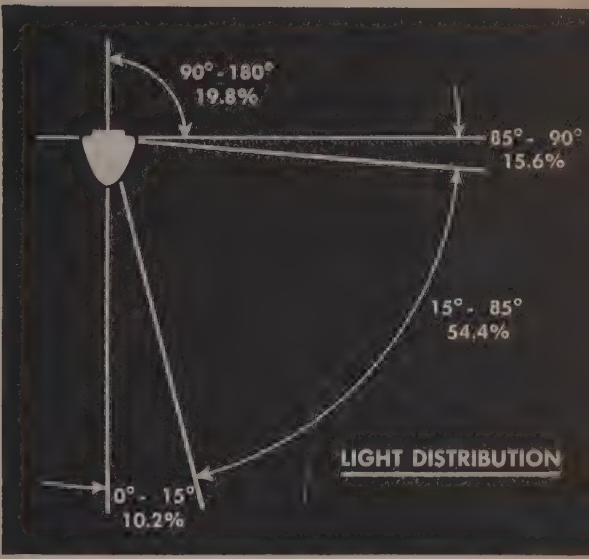
Answer: No.

Question No. 2—A building has a 3-wire 120/240-volt service drop attached to the front of building. If an electrician installed a 3-wire service entrance cable from the service drop through the attic and down inside of the back wall of the building to feed the service equipment, would this be in accordance with Section 230-70b, 230-91, and the note following Section 230-44 of the 1959 National Electrica Code?

Answer: No.

Attractive LPI VeeLens corridor luminaire has V-shaped prismatic diffuser and convex reflector which concentrates greatest amount of light on wall areas. Viewed endwise, it provides excellent brightness control—maximum brightness does not exceed 350 footlamberts in the 45° to 90° zone.





Light distribution for LPI VeeLens. Percentage figures show amount of light (based on 100% for half the luminaire) which falls in various sectors. Upward component permits proper brightness ratios and relieves contrast on the corridor ceiling.

New, low-cost LPI VeeLens puts high levels of useful light on corridor walls

The VeeLens fluorescent corridor luminaire is engineered for efficient application to school corridors, library stacks, stock room aisles, and pedestrian tunnels. It solves the two important corridor lighting problems at lowest possible cost: (1) most of the useful light is directed where you want it—on the vertical surfaces, and (2) brightness down the corridor is controlled to a comfortable level without glare.

Formerly, only far more expensive fluorescent luminaires with intricate shielding, or incandescent luminaires with special lenses directed the useful light so effectively. Now, LPI's VeeLens does the job better at lower cost because it utilizes a clear prismatic diffuser containing thousands of 8-sided prisms. This diffuser combined with the unit's convex reflector distributes useful illumination in the pattern most desirable for corridor lighting—the "butterfly curve." The result is a high level of illumination on the vertical surfaces with controlled brightness when viewing parallel to the luminaire.

VeeLens luminaires are available for surface or pendant mounting, individually or in continuous rows. They utilize one 48" rapid-start lamp in a 4-ft. luminaire, or two 48" rapid-start lamps, tandem, in an 8-ft. luminaire. Diffusers hinge from either side.

For complete information, write for VeeLens bulletin

LPI FLUORESCENT LIGHTING

Lighting Products Inc., Highland Park, Illinois

Grounding Fixtures

Q. *In a commercial building of masonry construction with a concrete floor, exposed steel-bar joist construction overhead 12 ft above the floor, the wiring method is rigid conduit with fluorescent fixtures suspended 18 in. on chains from the overhead conduit which is secured directly to the steel bar joists, the fluorescent fixtures are equipped with a 3-ft length of 2-wire heavy-duty cord with attachment plug to insert in receptacle outlets installed above each lighting fixture.*

Does the National Electrical Code require the metal housing of the fixtures to be grounded other than depending on the hanger chains for the grounding of such fixtures?—M.B.

A. Your question was discussed at the Southern Section, International Association of Electrical Inspectors meeting in Miami, Fla. in 1958, and from reading the discussion, one will see there is a difference of opinion concerning the matter. It was brought out in the discussion that Section 410-14 of the present code would allow the hanging of cord-equipped fixtures suspended directly below the outlet box, where the exposed cord is not subject to strain or physical damage. It was also brought out that a fixture located 8 ft above the floor would not require grounding, as Sec. 110-15(c) states:

"The elevation of the equipment at least 8 ft above ordinarily accessible working platforms, usually affords protection at least equivalent to that provided by the horizontal clearances of Paragraph 110-15(a), and may be used in lieu thereof."

B. Z. Segall, a consulting editor of this magazine, is recorded as making this statement which applies in your case:

"Usually you put it up with chains that gives you a ground to your fixtures. That takes care of all the necessary grounding."

Official Interpretation No. 52 was issued in 1939 concerning Section 4128 of the 1937 edition of the NEC (which is the same as 4216 of the '56 Code and 410-96 of the '59 Code, except that reference to gas piping has been deleted). Int. No. 52: French Hook Fixtures—

"Question: Are fixtures hung on French hooks to be considered as grounded as specified in section 4128 of the National Electrical Code?

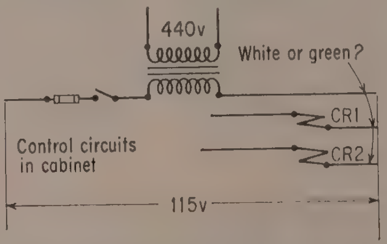
Finding: Determination as to acceptable grounding under the above conditions is dependent upon circumstances observed at each individual installation. When the French hook is of metal and a metal fixture and strap is hung upon it, it would appear that acceptable grounding is readily possible, *at least to the same general extent as with the chain-type of fixture.*"

The latter part of this interpretation indicates to me that chain-type fixtures were generally acceptable as a grounding means even before this Official Interpretation was issued in 1939.

Although there is a difference of opinion on the question, my answer to your question is that if I was inspecting the job, no additional grounding would be required as tests recently made at UL verifies Mr. Segall's statement regarding chains for grounding fluorescent fixtures.—R.E.W.—8/60/7

Grounded Conductor —Identification

Q. *A question arose as to what is the proper color for the wires in the diagram below?—C.N.M.*



A. According to the provisions of Section 200-6 of the 1959 Code, the grounded conductor derived through the transformer must have outer identification of white or natural gray color as required by Section 310-2(f). The provisions of Section 200-7 definitely state that conductors having white or natural gray covering shall not be used other than as conductors for which identification is required by Section 200-2. The foregoing rules concern conductors which are intentionally grounded as required by Section 250-5.

The provisions of Section 210-5 read as follows:

"Any conductor intended solely for grounding purposes shall be identified by a green color unless it be bare. Conductors having a green covering shall not be used for other than grounding purposes.

"See Section 200-7 for use of white or natural gray for grounded or neutral conductors."

In view of the foregoing rules, the intentionally grounded conductor derived through the transformer, as shown on your diagram, must be identified by a white or natural gray covering. It could not be identified by a green color since this color is reserved solely for "a conductor used to connect an equipment, device or wiring system with a grounding electrode or electrodes." (See definition of grounding conductor.)

A grounded conductor is defined as follows:

"A conductor which is intentionally grounded, either solidly or through a current-limiting device."

When the distinction between these two definitions is fully understood, there should be no difficulty in applying pertinent code rules.—B.A.McD.—8/60/8

Thermoplastic Wire

Q. *Within the past few months we have purchased wire marked THW.*

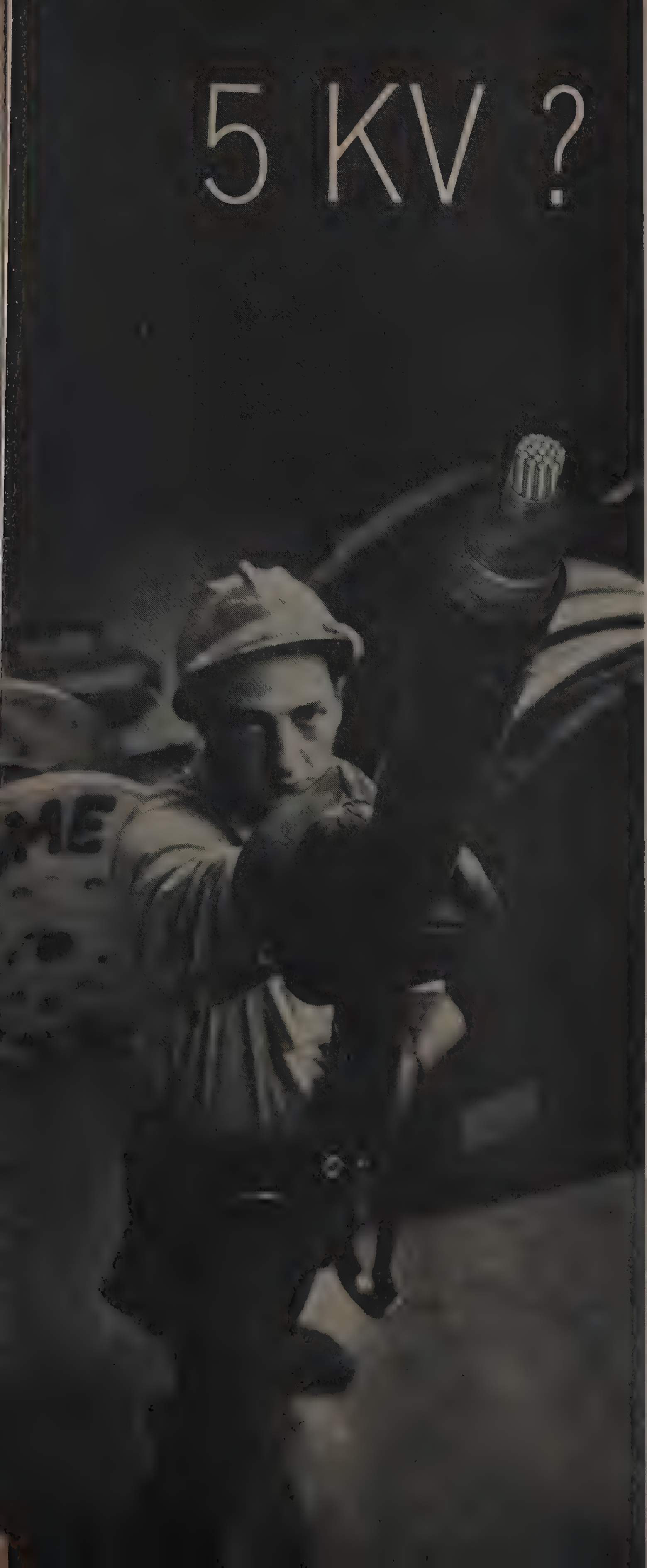
Is the above marked wire a new product? If so, what is the difference between the THW and ordinary thermoplastic such as T or TW?—N.M.

A. In answer to the first part of your question, THW is a comparatively new type insulation as it was listed by Underwriters' Laboratories in 1959. Many wire manufacturers now have the wire listed, and apparently it is meeting with widespread approval.

The answer to the last part of your question is covered in Table 310-2a of Article 310, 1959 National Electrical Code. From the above mentioned table it will be noted that type T wire (thermoplastic) may be used in dry locations with maximum operating temperature of 60° C or 140° F. TW moisture-resistant thermoplastic may be used in wet locations as well as dry locations with the same maximum operating temperature as the type T wire. THW is a moisture and heat-resistant thermoplastic that may be used in dry and wet locations with a maximum operating temperature of 75° C or 167° F.

You can see from the above that the THW has broader usage with higher operating temperature.—R.E.W.—8/60/9

5 KV ? 15 KV ?



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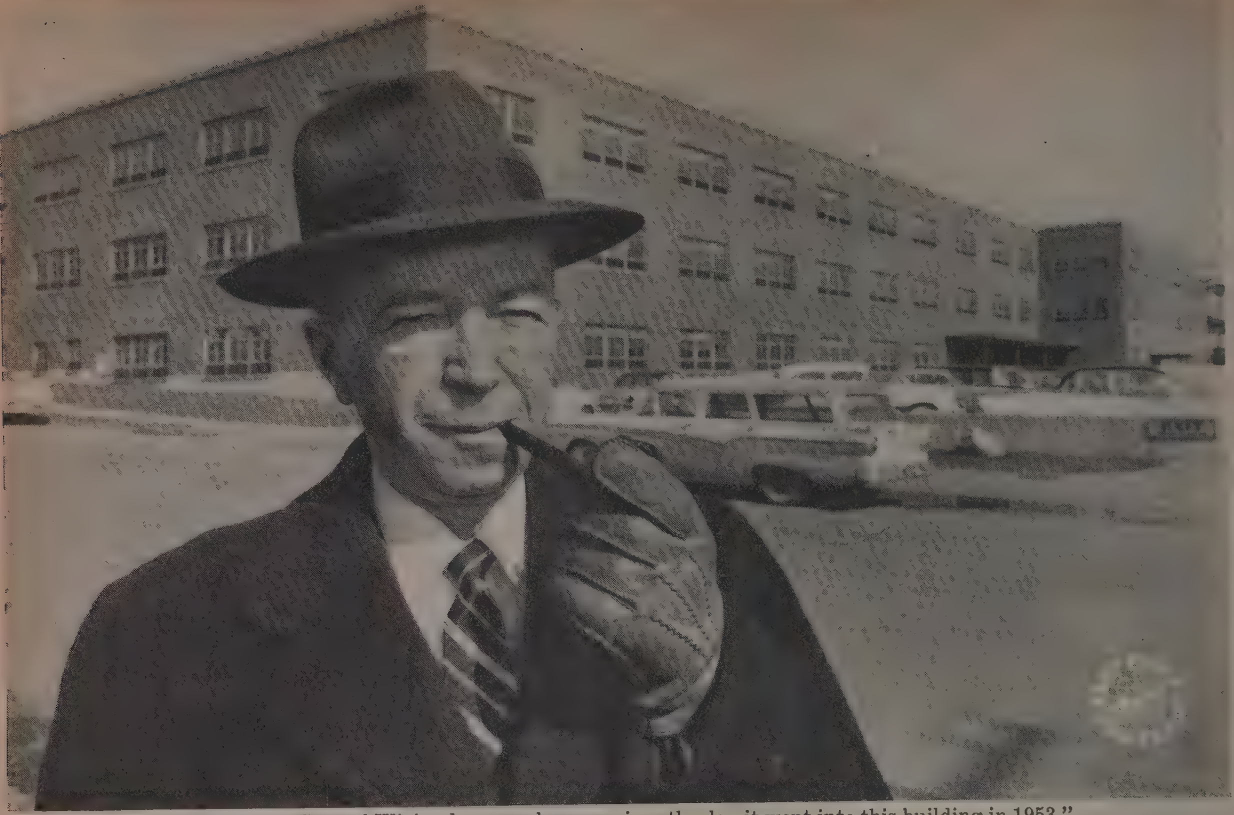


"G-E Remote-Control Wiring has saved money since the day it went into this building in 1953," says Mr. Donnelly, standing in front of 3-story, block-long office building, Menands, N. Y.

"G-E Remote-Control Wiring saved us $20,561 in this N. Y. Telephone building - on installation alone!"

. . . Mr. H. J. Donnelly, Supervising Electrical Engineer New York Telephone Company, Albany, N.Y.

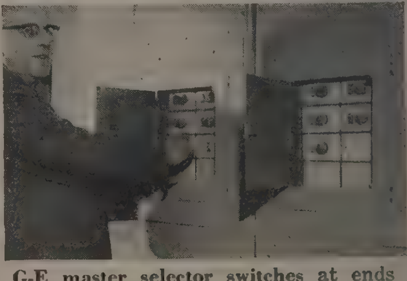
"We compared General Electric Remote-Control with an ordinary switching system that would give us the kind of lighting control we wanted," says Mr. Donnelly. "We were surprised to find that, in addition to its other advantages, the G-E low-voltage system cost $20,561 less to install!

"On top of the initial savings, we reduced our operating costs, because G-E master switching makes it easy for maintenance crews to turn ON only those lights needed, rather than lighting up whole floors. Switches at convenient locations save our men extra steps, too.

"These savings were all in addition to the original reason we considered Remote-Control. That was extra safety in controlling the 480Y/277-volt power system we chose for its saving in branch circuit copper. Remote-Control relays in the ceiling control the 277-volt lighting circuits, so there's only a low, 24 volts at the switches. Of course, the lightweight, 24-volt switch wiring makes it easier to relocate office partitions, too. And the elimination of switch-loop voltage drops that can cut the life and efficiency of lamps, is still another feature."

General Electric would appreciate the opportunity of working with you on the design of a Remote-Control Wiring System tailored to fit your particular needs. Write Commercial Engineer, General Electric Company, Wiring Device Department, Providence 7, Rhode Island.

"Douse the lights you don't need!" is standard procedure for maintenance crew, in building from 5:00 to 11:00 p.m. G-E Remote-Control makes it easy.



G-E master selector switches at ends and center of each floor control lighting separately for each ½ floor. Building contains 2000 fluorescent lamps.

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Webster Named Chairman of NEW

Harold A. Webster, president of the National Electrical Contractors Association, has been named chairman of 1961 National Electrical Week. Mr. Webster, president of T. Frederick Jackson, Inc., Long Island electrical contractors, succeeds N. J. MacDonald, president of The Thomas & Betts Co., Inc., Elizabeth, N. J., and president of the National Electrical Manufacturers Association.

Mr. Webster has served as treasurer of the NEW Committee since its formation in 1956. Other officers for the 1961 observance are: vice chairman—T. O. McQuiston, vice president, Metropolitan Edison Company, Reading, Pa.; secretary—Arthur W. Hooper, executive director, National Association of Electrical Distributors, New York; treasurer—L. W. O'Brien, manager of Monogram & Syndicated Information, General Electric Company, New York.

As chairman of NEW, Mr. Webster will head the 25-man committee which represents the various electrical industry organizations throughout the country. The 1961 observance, to be held February 5-11, will mark the fifth year of the event which is staged to call attention to the importance of electricity and the contributions the industry makes to our economy and progress.

NECA District Four Meets in Wisconsin

Contractors from a four-state region (Ill., Ind., Wis., Mich.) took a long, hard look at the present status of the electrical contractor during the annual meeting of District Four, National Electrical Contractors Association, at Eagle Waters Resort, Eagle River, Wis., July 13-15. What they saw and heard was not too encouraging. Contractors (IBEW employers) are getting a smaller percentage of the total annual construction, maintenance and repair work. There appears to be too much concentration on "post card bidding," not enough aggressive selling, and a general attitude of complacency that has no place in a dynamic industry. That was the picture prominent speakers gave some 300 members and guests.

BUSY WORKERS at the convention of the New York State Association of Electrical Contractors and Dealers, Inc., held at Whiteface Inn, Lake Placid, N. Y., were J. M Smith, Smith Electric Co., Inc., Cohoes, N Y.; Harold A. Webster, president of NECA and T. Frederick Jackson, Inc., Long Island City; and W. L. Drexler, Henry Drexler, Inc., New York City.

Reverting to specifics, Paul M. Geary, executive vice president, NECA, revealed that of an estimated $15 billion annual volume of electrical construction, maintenance and repair, some 12,000 electrical contractors (IBEW) were getting only $3 billion in work. Of the rest, about $1 billion is done by 9,000 non-union contractors. The other $11 billion is being done by other branches (plant crews, etc.) who are absorbing the functions of the electrical contractors, he noted. A majority of NECA members are confining their activities to new construction fields; are diverting their sales efforts to becoming "preferred bidders"; are indifferent to the amount of business there is in other fields, he added. Local chapters should get behind the "area market survey" program and periodically document what is happening in their own areas for local use, Geary suggested. He recommended that suppliers turn over the consumer sales function to contractors; noted that suppliers' salesmen could become contractors' salesmen without anyone being hurt. Mr. Geary also reviewed other association activities, including upgrading of Benefit Fund pensions, promotion of fair bidding practices, and a program to progressively "nationalize" all fringe benefit plans.

Because of apparent complacency, most electrical contractors are at a standstill and not moving with present markets, M. J. Sherwood, NECA director of marketing, told the conference. In spite of dollar volume growth in electrical construction, contractors are doing a smaller percentage each year. Last year it was only 21.3%; in 1958, it was 23%, he noted. Electrical contractors profit before taxes, based on a seven-year average, is only 4.5%. To make a fair profit, Sherwood urged conractors to stop concentrating on the "post-card bidding" new construction market; stop selling price; do a creative selling job at their own local level; hire salesmen; set up residential wiring departments to capture their share of the residential market. NECA's Sales Training Institute is being developed to train and establish a pool of salesmen for electrical contractors, he revealed. What to sell? Sherwood noted, among others, the following: electric heat, relighting, rewiring, contract maintenance, electronic systems-communications, alarms and similar items.

Bid shopping and bid peddling have been the bane of mechanical subcontractors (including electrical) for many years. With the proportionate cost of mechanical and electrical work now ranging upwards from 40% of total building cost, the abuses of the single-contract system have grown. To combat these abuses, Jack W. Collins, manager, Chicago Chapter, NECA, announced the Chicago Plan for Separate Bids developed by the Coordinating Committee of Mechanical Specialty Contractors Associations of Chicago. This program, which will be vigorously promoted in the area, calls for preparation of separate specifications for heating, plumbing, electrical and ventilation work; taking of separate bids and letting of separate contracts to the qualified low bidder in each of these categories; provision for direct payments to mechanical specialty contractors if their work is optionally assigned to the general contractor.

The need for adequate job insurance was emphasized by L. M. Anderson, Milwaukee manager, Travelers Insurance Company of Hartford. Noting that the average electrical contractor spends about 10% for such insurance, he reviewed the various coverages available and the pitfalls a contractor must protect himself against both in coverage and policy terminology.

NECA labor relations director

J. E. Swan discussed labor relations and the new law. A. S. Kerr, legal counsel for the Detroit Chapter, NECA, considers anti-trust legislation, next to tax regulations, the most formidable set of laws business has had to face during the past eight years. Citing specific case examples, he emphasized the importance of contractors knowing what they can and can not do in the eyes of the law.

Labor has the responsibility of developing more skilled manpower for the electrical construction industry, said H. P. Hagberg, business manager, IBEW Local 697, Gary and Hammond, Ind. Noting that some contractors are forced to limit their work load due to lack of competent workmen and acknowledging that some journeymen with cards have little or no ability, he suggested that the IBEW constitution set up minimum requirements (through examination) for journeymen on a universal national basis. Apprentice and journeymen training programs should be established and financed in all areas, he added. Despite the labor movement merger, Hagberg believes the CIO is a greater threat today than ever before particularly in the steel, automotive and chemical industries.

While covering the role of electrical codes in fire prevention, W. P. Hogan, chief electrical inspector, Chicago, revealed that 60% of Chicago's electrical fires were caused by do-it-yourself projects installed without benefit of inspection. Predicting an upswing in electrical fires due to "old wiring," he noted that his department is sending out more than 500 letters per month to home and building owners urging them to bring their electrical systems up to standard. Hogan is firmly convinced that electrical fire detection and alarm systems, not sprinklers, are the answer to preventing a repetition of Chicago's tragic parochial school fire. While sprinklers may protect property, alarm systems alert children for orderly evacuation before smoke and fire can gain overpowering headway, he continued, emphasizing the need for adequate emergency and exit lighting systems in all buildings housing large groups of people. Electrical contractors were urged to offer their technical background and "brainpower" to groups establishing modern electrical and fire safety regulations.

E. J. SIMMONS, Triangle Conduit & Cable Co., New Brunswick, N. J., and Howard Marks, Nager Electric Co., Inc., Brooklyn, N. Y., attended meetings of the New York State Electrical Contractors and Dealers, Inc., at Whiteface Inn.

J. W. WERTHER and Joseph Benedetti of Werther Electric Co., New York City, attended the District No. 1 meeting of the National Electrical Contractors Assn. at Montauk, N. Y.

Electric heating should be promoted and sold by the electrical contractor and not left to manufacturers' and distributors' salesmen, cautioned Milwaukee contractor Eugene Kasal, president, S. P. Electric Co., Inc. He estimates an electrically heated home job requires twice the electrical manhours used on an average fossil-fuel home; that the electrical contract can be upped to 7 to 8% of the cost of the home compared to 2 to 3% for the conventional residential wiring job. Heat your own home electrically, then sell from personal experience, Kasal recommended. Apartment houses and such limited occupancy units as hotels and motels are a natural market for electric heat, he concluded.

During the demonstration workshop conducted by Dr. C. D. Phillips and J. B. Murphy, NECA management analysts, contractors engaged in serious self-appraisal of their respective business operations. Reports following evaluation comparison, revealed a wide area for improvement in such programs as diversification, promotion and sales.

The three-day conference was chairmanned by E. E. Leasure, Jr., Chicago, present and re-elected vice president of District Four, NECA.

Postpone Enforcement On Non-Interchangeable CB's

Section 240-25 (g) of the 1959 National Electrical Code states that circuit breakers shall be of the non-interchangeable type under certain conditions. According to this requirement, CB's for lighting and appliance branch circuits in residential and other occupancies where conditions of supervision do not assure that the CB's will be maintained at proper rating to protect the size of wiring must be non-interchangeable among three ranges of size. Units are classified according to physical size and construction into three groups: units rated 0 to 20 amps; units rated 21 to 50 amps; and units rated 51 to 100 amps. Such CB's or their mounting or bussing methods must be such that after a CB has been installed it will be difficult to replace it with a CB of higher ampere classification. For instance, it must not be too easy to remove a 20-amp CB and replace it with a 30-amp CB.

The above provisions were to become effective on July 1, 1960—according to the code. However, the Middle Department Association of Fire Underwriters, covering electrical inspection in six eastern states, has extended the date of enforcement of this rule to October 1, 1960. This extension was made necessary by the absence of industry standards or approval of suitable equipment for the job. The time extension will allow circuit breaker manufacturers to clear their equipment with the Underwriters' Laboratories and enable supply houses to dispose of their stocks of the old type breakers.

A. LINCOLN BUSH, honorary chairman of the convention of the New York State Electrical Contractors and Dealers, Inc., and Charles A. Selby, president, Vermilya Brown Company, Inc., New York City, were speakers at meeting held at Whiteface Inn.

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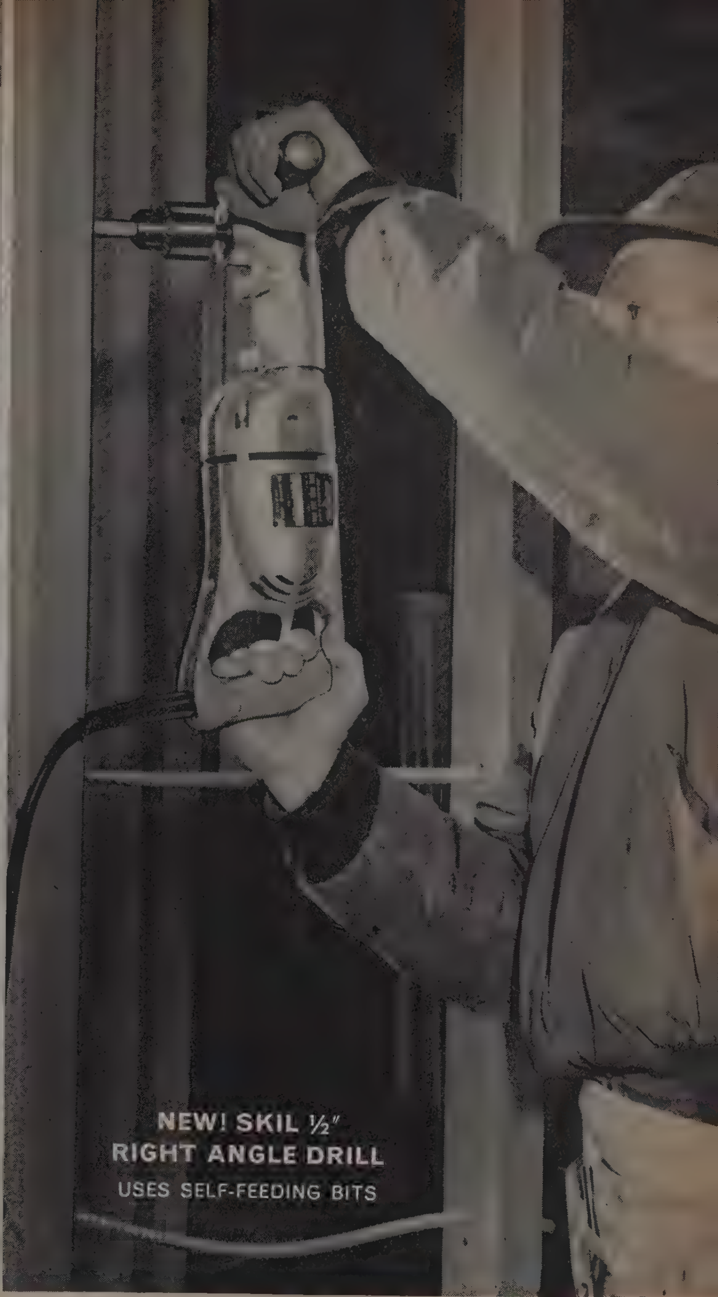

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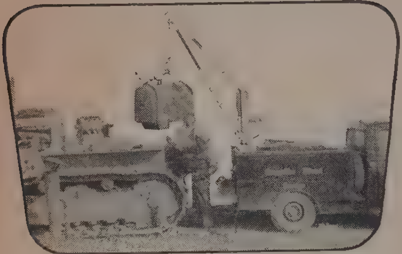

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NYS Contractors Meet in Lake Placid

The 61st annual convention of the New York State Association of Electrical Contractors and Dealers was held at Whiteface Inn, Lake Placid, N. Y., July 5 to 8.

H. A. Webster, president, T. Frederick Jackson, Inc. of New York and president of the National Electrical Contractors Assn., was chairman on contractors day. In opening the program he referred to some of the problems of the industry including those of single and separate contract letting, which set the theme developed by the speakers who followed.

C. A. Selby, president of Vermilya Brown Co., Inc. of New York, spoke of the merits of single contract system versus the separate contract methods as seen by the general contractor. He said that general contractors coordinate the work of and are responsible for the various specialty contractors; that private construction operates under single contract systems; and he alleged the cost of supervision of separate contract letting added to the cost of jobs.

Mr. Selby also acknowledged the abuses existing in the industry and deplored the unethical practices arising from bad bid practices, including bid peddling and bid shopping, and rising irresponsible subcontractors. He made specific recommendations for the correction of these abuses in the interest of mutual constructive progress.

The next speaker, F. H. Zurmuhlen, Commissioner of the Department of Public Works, City of New York, presented the owner's viewpoint on the subject, both as a public official and a practicing engineer prior to his career in government service. The Commissioner explained the laws, rules and procedures for public letting and how they differed from the practices existing in private construction.

He said that public, competitive bidding protects the people from unethical bidding practices. The laws of the State of New York require general construction in excess of the sum of $25,000, to be let in at least four separate contracts, including the general construction, plumbing, heating and electrical work. This system prevents low bid, unethical general contractors from bid peddling the mechanical component parts of the job. It also insures to the government better jobs by responsible specialty contractors, who do not obtain their contracts under such pressures.

The concluding speaker of the day, G. B. Roscoe, director of public relations, NECA, presented a report on the work of the Council of Mechanical Specialty Contractors and Associated General Contractors, and its progress. Mr. Roscoe spoke of the recommended procedures for receiving and handling sub-bids for the building construction industry for public and private construction to eliminate misunderstandings and abuses sometimes associated with these procedures. He stated the committee firmly believes that the industry, as represented by its recognized associations, is capable of honestly recognizing these problem areas and effectively initiating remedial actions within the industry. Mr. Roscoe made specific recommendations for industry cooperation on both local and national levels.

C. W. Meytrott, vice president of Consolidated Edison Company, New York, was chairman on utility day. He pledged the complete support of the operating electrical utilities in the State of New York to the NECA program that utilities do not engage in the business of electrical contracting by providing or subsidizing electrical installations to increase load on their lines.

J. E. Doolittle, vice president, Central Hudson Gas and Electric Corp., Poughkeepsie, discussed electrical construction adequacy in both new buildings and modernization of existing structures. A. C. Sugden, engineering manager, Long Island Lighting Co., Mineola, spoke on "New Ideas in Power Generation."

W. A. Lyons, vice president, New York State Electric and Gas Corp. Binghamton, presented figures on utility growth required to keep pace with the increased electrical energy demands for business and residential use.

Robin S. Kersh, vice president, Westinghouse Electric Corp., New York, was chairman on manufacturers and wholesalers day. Marshall N. Waterman and C. F. Jensen of Westinghouse Lamp Division submitted a joint presentation on the subject of light sources —present and future—and their applications.

H. R. Wallrath, manager of the Construction Industries Sales Apparatus Division, General Electric Co., Schenectady, reported on the current and future apparatus trends for engineered construction.

A. W. Hooper, executive director, National Association of Electrical Distributors, spoke to the

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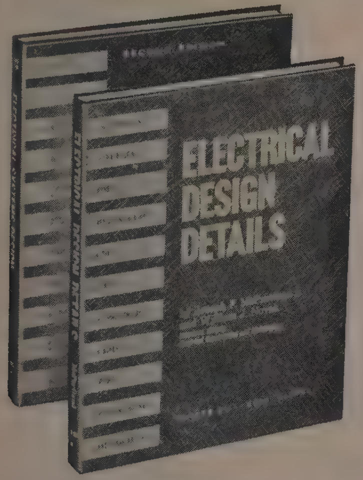

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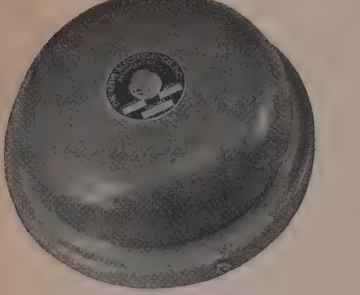

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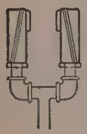

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H. F. Janick of Rochester was re-elected president; H. A. Webster, New York, 1st vice president; J. M. Smith, Cohoes, 2nd vice president; R. J. Knoblock, Syracuse, treasurer; and J. P. O'Brien, Yonkers, financial secretary. Directors are E. G. May, Albany; C. H. Prindle, New York City; T. F. Farley, Utica; R. E. Goeller, Jr., New York; T. R. Meaker, Binghamton; M. A. Anderson, Jamestown; Charles Chandesh, New York.

NISA News

The 28th Annual Convention of the Electrical Apparatus Service Association, Inc.—the new name as of next April 1 of the National Industrial Service Association, Inc.—will be held in San Francisco, Calif., June 11-14, 1961, at the new Jack Tar Hotel, it has been announced by J. Arthur Turner Jr., Tampa Armature Works, Tampa, Fla., international president.

Plans to hold the 1961 convention in Denver, Colo., had to be cancelled when hotel exhibit and dining facilities proved to be inadequate for the association's growing needs, Mr. Turner explained.

More than 1,000 operators of electric motor, generator and transformer service and sales firms in North America are expected to attend the convention, the first on the West Coast since the association met in Los Angeles in 1955. A site for the 1962 convention, originally scheduled for San Francisco, will be announced later, Mr. Turner said. EASA plans to hold its 1963 convention in Chicago and its 1964 convention in New York.

Members of EASA's Northern California Chapter will act as hosts for the convention, Mr. Turner said. Other EASA chapters that will assist the association's national headquarters in planning the convention are the British Columbia, Oregon, Rocky Mountain, Los Angeles and San Diego Chapters.

Information about exhibit space may be obtained from Joseph M. Harrington, executive vice-president, National Industrial Service Association, Inc., 7730 Carondelet Avenue, St. Louis 5, Mo.

• • • •

Approximately 200 members and wives are expected to attend the joint meeting of Wisconsin, North Central and Midwestern chapters in Minneapolis, Sept. 15-17 at Hotel Normandy.

The meeting, first joint gathering of these chapters which embrace motor shops in Wisconsin, Iowa, Nebraska, Minnesota and the Dakotas, will be addressed by Joseph Ferrari, Excel Electric Co., Chicago, Ill., a NISA director; Arthur C. Roe, staff engineer at NISA St. Louis headquarters; and Horace Barks, of Horace Barks Publications, St. Louis, Mo., editor of *NISA News*.

Q. C. Teich, Electrical Engineering & Equipment Co., Des Moines, Iowa, is general chairman; J. J. Anderson, A & P Electric Repair, St. Louis, Mo., is arrangements committee chairman; and David Thornell, Electric Motors Unlimited, Madison, Wis., is program chairman.

Assisting the chairmen will be: Bill Bock, H. A. Holden Co., Minneapolis; Robert H. Root, Electric Motor Supply Co., Minneapolis; H. F. Peterson, A & P Electric Repair, St. Paul; Lewis Whitted, Clinton Electric Motors, Clinton, Iowa; and Mrs. Julian Hupp, Electric Motors Co., Cedar Rapids, Ia.

• • • •

Austin, the Texas capital, will be the site of the fall meeting of Southwestern Chapter, George Kinard, of Beaumont, Texas, president, has announced.

Mrs. Fred Kramer has been appointed chairman of the women's committee, Mr. Kinard said.

• • • •

The General Electric appliance factory in Murfreesboro, Tenn., was host to members of Mid-South Chapter during their tour of the plant facilities June 17.

"Pension and Profit-Sharing Plans" was the topic of a talk by J. W. Coles, of the First American

National Bank of Nashville. "Repair and Service of Industrial Electronic Equipment" was the subject of a talk by J. G. King, Reliance Electric and Engineering Co., Atlanta office.

• • • •

The Second "Practical-Technical Seminar" for the testing of materials and equipment was held in Birmingham, Ala., July 21-23. The first Seminar was held in St. Louis last March and several others are scheduled for this fall and early next year.

NISA members pay $25 registration fee for the privilege of winding motors for three days under the supervision of staff engineer Arthur C. Roe. Results are calculated and disseminated to the membership after exhaustive tests have been made on various kinds of wire and insulation.

More than 50 shop men were present at the Birmingham Seminar, held at Electric Motor Service, Inc., of which NISA director Walter Brush is owner.

• • • •

John Wagner was reelected president, Selden High treasurer and Hank Jahn secretary at a recent meeting of Cincinnati Chapter. E. L. Stone was elected vice-president to replace the late Harry Hennequin.

• • • •

Walter R. Yogerst, general sales manager, Bodine Manufacturing Co., Chicago, was the principal speaker at the meeting of Great Lakes Chapter June 20 at Howard Electric Co., Detroit, Mich.

C. B. & S. Electrical Co., Dearborn, and Milne Electric Motor Shop, Ysilanti, Mich., were cohosts with the Howard firm at a buffet dinner preceding the meeting.

• • • •

Ber-Cason Electric Motor Corp. has joined the Great Lakes Chapter of NISA. David Berger and Herbert Case will represent the firm at the group's meetings.

• • • •

William Carley, Corrosion Reaction Consultants, Philadelphia was the chief speaker at a meeting of Chicago Chapter June 14 at Petricca's Restaurant.

• • • •

A meeting of Florida shops was held on July 27 in Orlando.

• • • •

Walter Helwig, president, Helwig Carbon Products Co., Milwaukee, Wis., was the chief speaker at a meeting of Wisconsin Chapter on May 24 at Moonbi Inn.

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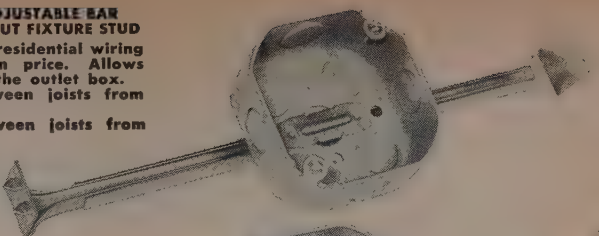

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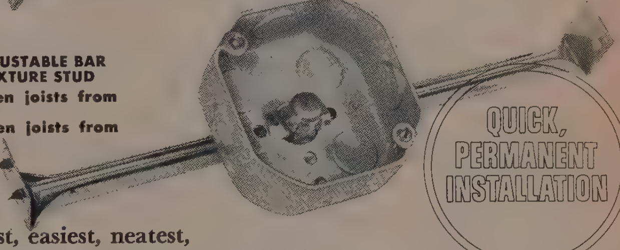

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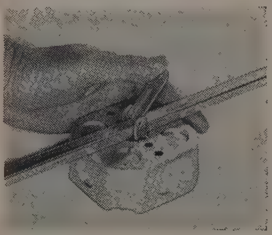

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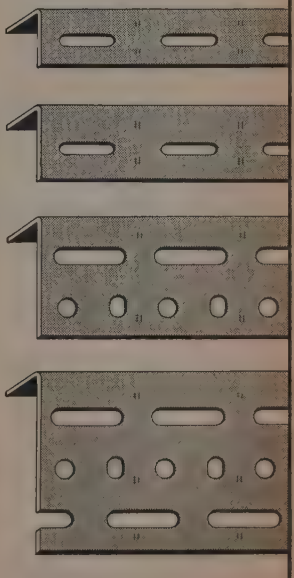

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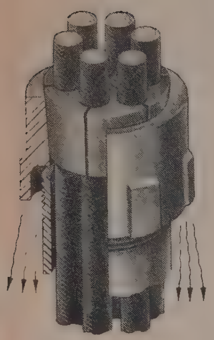
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National Association of Lighting Maintenance Contractors—National Conference, Milwaukee Inn, Milwaukee, Wis., August 22-24.

Illuminating Engineering Society—National Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa., September 11-16.

International Association of Electrical Inspectors — Northwestern Section, Sheraton-Portland Hotel, Portland, Ore., September 12-14; **Southwestern Section**, Mapes Hotel, Reno, Nev., September 19-22; **Eastern Section**, Wentworth-By-The-Sea, Portsmouth, N. H., September 26-28; **Western Section**, Continental Hotel, Kansas City, Mo., October 3-5; **Southern Section**, Rice Hotel, Houston, Texas, October 17-19; **Canadian Section**, Toronto, Ont., Canada, Oct. 28-29.

NISA Chapter Meetings — North Central, Midwestern and Wisconsin, Minneapolis, September 16-17; **Central Ohio**, Columbus, Ohio, September 18; **Southwestern**, Austin, Texas, September 22-24; **King Coal**, Evansville, Ind., October 13, and Mount Vernon, Ill., January 12, 1961.

Pennsylvania Electric Assn.—53rd annual meeting, Penn-Sheraton, Pittsburgh, Pa., September 20-22.

The Ninth Annual National Symposium on Industrial Electronics—Symposium jointly sponsored by AIEE and IRE, Manger Hotel, Cleveland, Ohio, September 21-22.

American Welding Society—Fall Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa., September 26-29.

International Association of Electrical Leagues—25th annual conference, Hotel President, Kansas City, Mo., October 5-7.

National Electronics Conference—Hotel Sherman, Chicago, Ill., October 10-12.

Florida Association of Electrical Contractors—Annual Convention and 8th Electrical Trade Show, Deauville Hotel, Miami Beach, Fla., October 12-15.

National Electrical Contractors Association—1960 annual convention, Las Vegas Convention Center, Las Vegas, Nev., October 23-27.

American Standard Assn.—11th National Conference on Standards, Sheraton-McAlpin Hotel, New York City, October 25-27.

International Association of Electrical Inspectors—NFPA Fall Conference, Columbus, Ohio, November 14-16.

National Electrical Manufacturers Assn.—Annual meeting, Traymore Hotel, Atlantic City, N. J., November 14-18.

Electrical & Home Appliance Show—Electrical Building, Balboa Park, San Diego, Calif., November 25-30.

The Third National Conference on the Application of Electrical Insulation—Co-sponsored by the AIEE and NEMA, Conrad Hilton Hotel, Chicago, Ill., December 5-8.

Among the Manufacturers

Headquarters Announcements

Wheatland Electric Products Co. will now be located at their new plant-office building at 500 Logan St., Carnegie, Pa., with Herbert Wrozina factory manager.

Heifetz Co., Clinton, Conn., has announced the formation of Rodisco, Inc. as a division.

Coolerator Div. of McGraw-Edison Co. with main offices in Albion, Mich., will now be known as the **Albion Div.**

McGraw-Edison Co., Chicago, Ill., announced the acquisition of the Alrectic Div. of the Handley-Brown Co., Jackson, Mich., with Harold Handley as president and general manager of the division.

Johns-Manville Corp., Industrial Insulations Div., New York, N. Y.—John Jobe, general manager.

Carrier Corp., Syracuse, N. Y.—Charles V. Feen, Russell Gray, Melvin C. Holm and Walter Steitler, executive vice presidents.

Electric Regulator Corp., Norwalk, Conn.—W. Hamilton Walter, vice president.

National Carbon Co., New York, N. Y.—James R. Johnstone, president.

Hitemp Wires, Inc., Westbury, N. Y.—Francis X. Buschman, director of research, development and engineering.

Radiant Lamp Corp., Newark, N. J.—Edmund G. Taussig, sales manager.

The Okonite Co., Passaic, N. J.—H. L. Ledermann, assistant manager-product advertising.

Burndy Corp., Norwalk, Conn.—Julian Rogoff, executive vice president; Fred Heller, manager of the Amaton Div.

Buell Engineering Co., Inc., New York, N. Y.—Jack L. Schumann, president and director.

General Electric Co., Plainville, Conn.—Thomas E. Lee, manager—product planning, Circuit Protective Devices Dept.; Alfred J. Carletti, manager—headquarters manufacturing, Distribution Assemblies Dept.

General Electric Co., Schenectady, N. Y.—William B. Boyd, manager of manufacturing, Specialty Transformer Dept., Fort Wayne, Ind.

Gamewell Co., Newton, Mass.—W. Ben Flanigin, vice president.

The Siegler Corp., Paramus, N. J.—Harold A. Goldsmith, president, Bogen-Presto Div.

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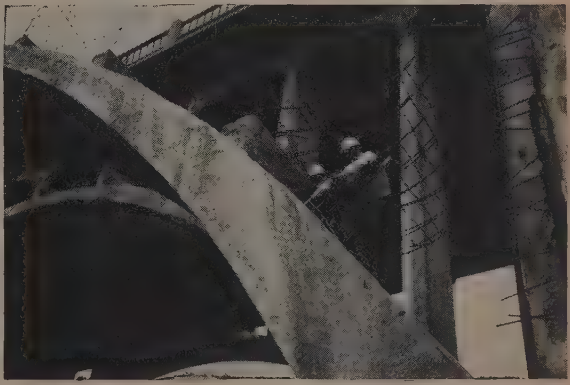

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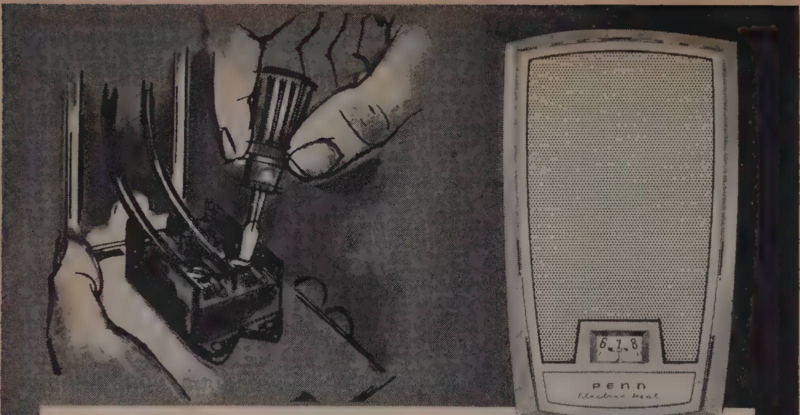

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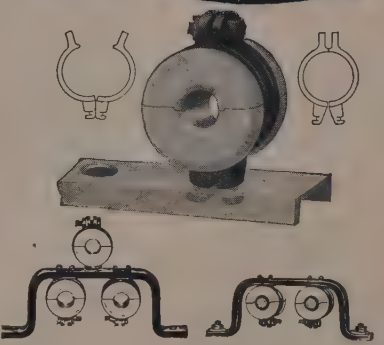

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General Electric Co., Cleveland, Ohio—Robert V. Corning, manager — marketing, Large Lamp Dept.

Marion Instrument Div. of Minneapolis-Honeywell Regulator Co., Manchester, N. H.—Edward S. Maury, vice president—engineering; Kenneth J. Cumming, marketing manager.

Corning Glass Works, Corning, N. Y.—Jack E. Mounteer, supervisor of lamp product engineering, Electrical Products Div.

Electric Regulator Corp., Norwalk, Conn.—James P. Ettinger, general sales manager.

The Electric Storage Battery Co., Philadelphia, Pa.—Oakley N. Dean, vice president—manufacturing, Exide Industrial Div.

Thomas C. Wilson, Inc., Long Island City, N. Y.—Mrs. Martha A. Wilson, board chairman; O. J. Bagnoli, president; and Alexander John, vice president.

Federal Pacific Electric Co., Newark, N. J.—C. A. Liming, marketing manager — power capacitors.

Robertshaw-Fulton Controls Co., Richmond, Va.—Arthur G. Baitz, director of engineering planning.

Leland Ohio Electric Co., Dayton, Ohio—G. William Schreck, sales manager.

Daystrom, Inc., Murray Hill, N. J.—John F. Morten, director of product planning, Weston Instrument Div.

McGraw-Edison Co., St. Louis, Mo.—Charles Edison, chairman of the board; Alfred Bersted, president; R. H. Giesecke, executive vice president and treasurer; Max McGraw becomes chairman of executive committee.

Pacific Semiconductors, Inc., Culver City, Calif.—Dr. Harper Q. North, president; Lawrence T. Lindgren, vice president—manufacturing; Dr. John W. Peterson, vice president—research and development; Sidney L. Spiegel, vice president—marketing.

Regional Appointments

NEW ENGLAND

Stanley Electric Tools: Clarence C. Wheeler, northeast regional manager.

Ramset Fastening System: James M. Voorhees, Jr., district sales manager for Connecticut, Rhode Island and northern New York, headquarters in New Haven, Conn.

Nelson Electric Mfg. Co.: Paul Edridge, eastern regional manager, headquarters in Boston.

Sylvania Lighting Products: Thomas H. Cashin, marketing manager and L. John Doyle, field sales manager—Large Lamp Products; Chalmer J. Carothers, sales manager—Industrial Commercial Lamps; headquarters in Salem, Mass.

Dynaray Div., Electro Powerpacs, Inc.: Charles D. White Co., Boston, Mass., representative throughout the New England States except Connecticut; John W. Anderson, plant superintendent of Manchester, N. H., plant.

MIDDLE ATLANTIC

Fasco Industries, Inc.: David M. Manley, sales representative in the New York-New Jersey area, headquarters in New York City.

Acme Electric Corp.: Arthur W. King, sales engineer for the Metropolitan New York area.

National Electric Div., H. K. Porter Co., Inc.: Frank E. Johnson, New York branch manager.

Lighting Services, Inc.: Bill Stern, Metropolitan New York sales engineer.

Weston Istruments Div., Daystrom, Inc.: Joseph F. Degen, vice president and general manager, Newark and Poughkeepsie; Edward L. Klein, vice president—operations, Newark.

SOUTH ATLANTIC

Vickers Inc.: W. E. Cook & Associates, Atlanta, Ga., sales representative in Atlanta area.

EAST CENTRAL

Stanley Electric Tools: Robert W. Brandt, east central regional manager.

LIGHTING MAINTENANCE by contract was explained to William Meineke, (left), electrical engineer, Visking Company, Flemington, N. J., by Francis Clark, Lighting Services, Waterbury, Conn , during the Plant Maintenance show in Philadelphia earlier this year. Mr. Clark operates a lighting maintenance business, and was representing the National Association of Lighting Maintenance Contractors.

Leonard Electric Mfg. Co.: James K. Faile, Cleveland district representative.

Bohn Aluminum & Brass Corp.: Walter T. Miiller, Chicago district sales manager.

Sylvania Lighting Products: Lawrence P. Pleasants, Cleveland district sales manager.

Wolverine Tube: Robert L. Chiddister, sales representative in the Chicago metropolitan area.

WEST CENTRAL

Fullman Mfg. Co.: R. E. Dunn Sales Co., Minneapolis, Minn., sales representative for Minnesota, North and South Dakota and western Wisconsin.

Allis-Chalmers Mfg. Co.: W. M. Johnson, manager of the utility section, St. Louis district; Russell A. Erickson, sales representative, Dallas district.

Day-Brite Lighting, Inc.: J. W. Hale, representative in the Houston, Texas area.

General Electric Co.: William D. Trammell, sales representative for the western district of the Silicone Products Dept., headquarters in Dallas, Texas.

Wolverine Tube: Edward F. Sweeney, sales representative for western Missouri and Kansas, headquarters in Kansas City, Mo.

Vickers Inc.: Fred Gross & Co., Dallas, Texas, sales representative in Dallas, San Antonio and Tulsa.

WEST

Allis-Chalmers Mfg. Co.: R. F. Kinney, sales representative, Albuquerque branch office.

Stanley Electric Tools: John M. Beyers, western regional manager.

Simplex Wire and Cable Co.: Heckerman Corp., Inglewood, Calif., western sales representative.

Dayton Industrial Products Co.: Gordon Zitting, district manager, Salt Lake City, Utah sales district.

S&C Electric Co.: Fred A. Allehoff, sales engineer for Oregon, Idaho and Montana, headquarters in Portland.

Auth Electric Co., Inc.: Harvey S. Wellman, district sales manager, headquarters in Los Angeles.

Harvey Aluminum: John Carder, Jr., Co., Albuquerque, N. M., sales representatives for aluminum rigid conduit in New Mexico, Utah, and El Paso, Tex.

Ramset Fastening System: Warren Duggan Sparks, sales representative in Los Angeles area.

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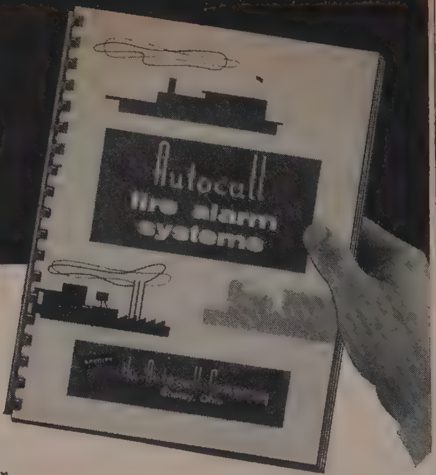

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VACUUM INDUCTION HEATING

[FROM PAGE 83]

Fig. 3 gives a general picture of circuit and equipment arrangements for the 5000-lb furnace.

The 30-cycle, low-frequency generator supplies 600 volts, 2-phase to two 400-kva transformers with a secondary voltage of 50 volts. Unique circuit arrangement allows 30-cycle and 890-cycle power to be applied to the work coil simultaneously. Isolating the four coil circuits from each other, an air-operated switch ties in the low frequency. Looking at the generator, the 30-cycle current feeds one side of the line. But looking at the coil, the 30-cycle current feeds across each individual circuit.

Control and protective circuitry is quite extensive. Approximately 5000 wires connect 17 control panels to various equipment. At the main power control panel, the furnace operator can vary generator power. And he can change transformer tap settings add capacitors, or switch voltage and power readings, or check generator-bearing and crucible temperature readings. Automatic operation is also possible. A power-factor relay will add or subtract capacitors as needed. Because the inductance of the coil varies during the melting cycle, the generator output must be varied to obtain maximum power. For maximum efficiency, a power-regulating panel automatically corrects power and voltage.

Tilting of the massive melt chamber can be done very accurately by means of an electro-hydraulic valve system. Pumping oil into the cylinders causes the chamber to tilt. And the amount of oil that the master hydraulic valve allows to pass regulates the speed at which the pistons rise. Controlled by the electro-hydraulic valve, a pilot hydraulic system in turn controls the master hydraulic valve. Circuitry is such that the electro-hydraulic valve coil is part of a bridge circuit in which, inserted in one leg, is the control rheostat. Tilting can be accomplished at control panels located at different levels.

Installation Problems

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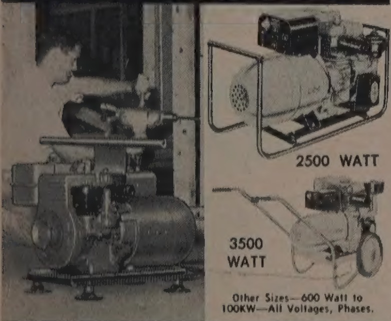

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out problems. When any deviation from the bus bar layout became necessary, we had to be extremely careful to avoid excessive line losses due to the large 890-cycle load. On parallel runs, opposite phases were alternately placed side by side and as close as possible to minimize X^r losses.

After preliminary testing we encountered our only major installation problem. This was corona. Corona is a luminous glow that appears on an electrical conductor when the electric stress near its surface becomes greater than the dielectric strength of the surrounding air. And corona occurs because of the ejection of ionized particles from the conductor and their collision with molecules of the gases composing the surrounding atmosphere. As a result, a chain reaction takes place, extending outward to a distance where the electric field strength cannot support it. Thus, corona is undesirable because it gives rise to considerable energy losses, and leads to eventual insulation failure.

Smoothness of conductor surfaces, temperature, composition of surrounding gases, and barometric pressure are some of the factors that determine the voltage at which corona appears. And perhaps barometric pressure is the most prominent factor. For a constant voltage, Paschen has shown that corona occurs in a range somewhere between a perfect vacuum and atmosphere. This is the range in which our coils operate. Therefore, they are quite vulnerable to corona.

In addition to corona, the operating conditions in the melt chamber also affect the proper performance of the coil. This is due to the fact that the coil insulation absorbs moisture from the wet refractory after ramming of the crucible. Also, during the melt-down, metal dust and soot can form unwanted electrical circuits, and the insulation is only inches away from the molten metal. In spite of these difficulties Swedish insulation experts, assisted by Metals Division engineers, worked persistently to design an insulation system that would operate unfailingly under such adverse conditions.

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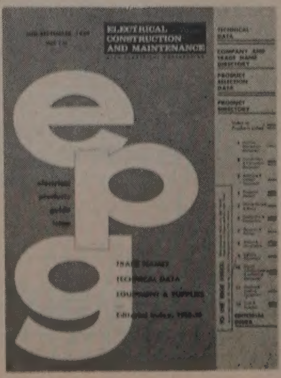

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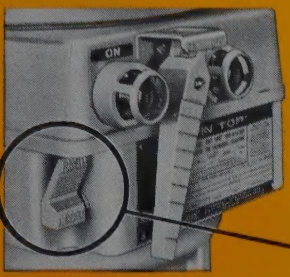

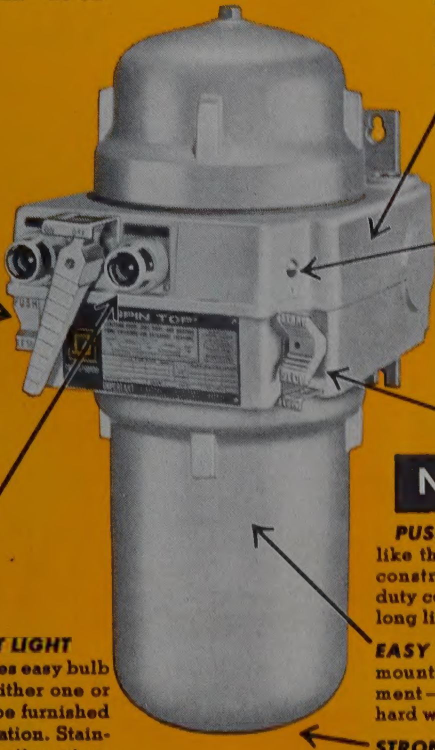

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